United States Government Accountability Office

Report to Congressional Requesters

March 2017

U.S. MANUFACTURING

Federal Programs Reported Providing Support and Addressing Trends

GAO-17-240

GAO Highlights

Highlights of GAO-17-240, a report to congressional requesters

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Federal Programs Reported Providing Support and Addressing Trends

Why GAO Did This Study

The U.S. manufacturing sector—representing about 12 percent of the economy and employing 12 million workers in 2015—has undergone changes over the last several decades. With increased productivity and technological innovation, the sector experienced a decreasing number of jobs and share of the economy. GAO was asked to examine how the federal government supports manufacturing.

This report examines (1) how selected federal programs and tax expenditures provide support to U.S. manufacturing; (2) how programs are addressing manufacturing trends; and (3) the extent to which agencies measure performance and assess effectiveness in support of manufacturing generally, and advanced manufacturing specifically. GAO reviewed selected programs with a focus on manufacturing, among other criteria, and conducted a survey of these selected programs to collect data on their budget, activities, and effects. GAO also reviewed reports and interviewed agency officials and experts.

What GAO Recommends

OSTP should identify the information it will collect from agencies to determine their progress in achieving the objectives of the National Strategic Plan for Advanced Manufacturing. In commenting on a draft of this report, OSTP neither agreed nor disagreed with the recommendation and suggested alternative language. In response, GAO revised the recommendation to focus on the identification of information, as discussed in the report.

View GAO-17-240. For more information, contact Andrew Sherrill at (202) 512-7215 or sherrilla@gao.gov, or John Neumann at (202) 512-3841 or neumannj@gao.gov.

What GAO Found

GAO identified 58 programs in 11 federal agencies that reported providing support to U.S. manufacturing by fostering innovation through research and development, assisting with trade in the global marketplace, helping job seekers enhance skills and obtain employment, and providing general financing or business assistance. Twenty-one of these programs reported using all of their obligations in fiscal year 2015 to support U.S. manufacturing. For these 21 programs, obligations of each program ranged from $750,000 to $204 million in fiscal year 2015, the most recent full year of data. Twenty-six other programs reported using funding to support manufacturing—in addition to other sectors—and provided ranges of estimates for the obligations directly supporting manufacturing. The remaining 11 programs either did not provide an estimate of their support to manufacturing or reported no program obligations in fiscal year 2015. GAO also identified nine tax expenditures that can provide benefits to manufacturers, amounting to billions of dollars in incentives for both the manufacturing sector and other sectors of the economy.

Most (51) of the 58 programs reported addressing trends toward an increase in advanced manufacturing (e.g. activities using automation, software, or cutting edge materials), the need for a higher-skilled workforce, and more global trade competition for U.S. manufacturers by providing funds and resources, sharing information, and promoting coordination. Survey responses from the 58 programs indicated that more than two-thirds of them are addressing the shift toward advanced manufacturing, approximately half are taking steps to address increased globalization and competition, and fewer than half are addressing the need for a higher skilled workforce.

Forty-four of the 58 programs reported having performance goals or measures related to the support of manufacturing, but agencies that comprise an interagency group have not identified the information they will collect from agencies and use to report progress in supporting advanced manufacturing. Ten of the 11 agencies that administer programs GAO reviewed participate in a federal interagency initiative to coordinate activities and report on progress in the area of advanced manufacturing. The Subcommittee on Advanced Manufacturing—co-chaired by the Office of Science and Technology Policy (OSTP) and that coordinates advanced manufacturing efforts—supports the updating and reporting on a National Strategic Plan for Advanced Manufacturing. The plan, which was published in 2012, identifies objectives and potential measures that could be used to assess progress. The subcommittee plans to report in 2018 on progress in achieving the strategic plan's objectives, as required by the Revitalize American Manufacturing and Innovation Act of 2014. However, OSTP has not worked with the subcommittee member agencies to identify the information needed to report progress in achieving the strategic objectives, such as what measures will be used. While subcommittee officials said the subcommittee does not provide top-down direction to federal agencies on how to measure effectiveness, specifying the information it will collect from federal agencies would better position it to report consistent and comprehensive information on the progress in achieving the plan's objectives.

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Abbreviations

3D	three dimensional
BETO	Bioenergy Technologies Office
BLS	Bureau of Labor Statistics
CDC	Certified Development Company
CES	Center for Economic Studies
CFDA	Catalog of Federal Domestic Assistance
COMPETES Act	America COMPETES Reauthorization Act of 2010
CRS	Congressional Research Service

DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
Education	Department of Education
GDP	Gross Domestic Product
HHS	Department of Health and Human Services
IMCP	Investing in Manufacturing Communities Partnership
IRS	Internal Revenue Service
ITA	International Trade Administration
JCT	Joint Committee on Taxation
MEP	Hollings Manufacturing Extension Partnership
MME	Manufacturing Machines and Equipment
NAE	National Academy of Engineering
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NSTC	National Science and Technology Council
OSTP	Office of Science and Technology Policy
PCAST	President's Council of Advisors on Science and Technology
RAMI Act	Revitalize American Manufacturing and Innovation Act of 2014
R&D	research and development
R&E	research and experimentation
SAM	Subcommittee on Advanced Manufacturing
SBA	Small Business Administration
SBIR	Small Business Innovation Research
STTR	Small Business Technology Transfer
TAA	Trade Adjustment Assistance
TAACCCT	Trade Adjustment Assistance Community College and Career Training Grant
TAAF	Trade Adjustment Assistance for Firms
Treasury	Department of the Treasury

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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Congressional Requesters

Manufacturing provides important benefits to the nation, such as employing 12.3 million U.S. workers and generating $2.2 trillion in economic activity in 2015.[1] U.S. manufacturing is comprised of businesses engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products, and includes various sectors of the economy, such as machinery, textiles, apparel, food production, and chemicals. Over the last several decades, U.S. manufacturing has undergone changes marked by increased productivity and technological innovation. However, these changes have been accompanied by a decline in the number of jobs in manufacturing and increased competition from other countries.

The federal government employs a broad range of programs and tax expenditures that can influence the manufacturing sector by helping businesses improve their efficiency, update their technologies, export their products, train their workers, and that can offer financial support in the form of loans or loan guarantees, among other things. These programs and tax expenditures are administered and overseen by a variety of federal agencies, and there is limited information on how they support manufacturing.

You asked us to provide information on how the federal government supports manufacturing. This report examines the following four questions:

1. How do selected federal programs provide support to U.S. manufacturing?
2. How do selected federal tax expenditures provide support to U.S. manufacturing?
3. How, if at all, do selected federal programs address manufacturing trends, and what, if any, challenges do they face?

[1]Bureau of Labor Statistics, *Manufacturing*, NAICS 31-33: Employment, all employees (seasonally adjusted), 1945-2016; and Bureau of Economic Analysis, *GDP by Industry,* 1947-2015.

4. To what extent do federal agencies measure performance and assess effectiveness in support of manufacturing generally, and advanced manufacturing specifically?[2]

To answer these questions, we identified selected manufacturing-related federal programs and tax expenditures, surveyed program officials, reviewed relevant reports, interviewed selected experts and agency officials, and conducted two site visits. To select programs and tax expenditures, we reviewed relevant GAO and Congressional Research Service (CRS) reports and the Catalog of Federal Domestic Assistance,[3] and we identified federal agencies that, according to those sources, administered programs that supported manufacturing.[4] We then contacted each of these agencies to obtain input about their programs. Programs included in our analysis met the following criteria: The program (1) was operational in fiscal year 2014 and at the time of selection in 2015, (2) had an identifiable focus on manufacturing,[5] and (3) was not part of a larger manufacturing program.[6] Next we contacted each agency again and requested that they confirm the programs we identified support manufacturing.

[2]According to a report by the President's Council of Advisors on Science and Technology (PCAST), advanced manufacturing represents activities that (1) depend on the use and coordination of information, automation, computation, software, sensing, and networking and/or (2) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences. It involves both new ways to manufacture existing products, and the manufacture of new products emerging from new advanced technologies. PCAST, Report to the President on Ensuring American Leadership in Advanced Manufacturing (June 2011).

[3]The Catalog of Federal Domestic Assistance contains detailed program descriptions for more than 2,000 federal assistance programs.

[4]In this report, we defined federal agencies broadly to refer to any federal organization that supports manufacturing.

[5]We determined that a program had an identifiable focus on manufacturing if it met one or more of the following criteria: (1) the program was called a manufacturing program in the program title; (2) the program's description, objectives, or eligibility criteria included that it specifically supports manufacturing; (3) agency officials stated that they could identify the number of participants or beneficiaries that are in manufacturing (e.g. manufacturing firms or workers trained in manufacturing); (4) agency officials could identify the amount of the program's budget that benefits manufacturing; (5) the program's goals, performance measures, or performance metrics include a specific focus on manufacturing; or (6) the program has been evaluated on its effect on the manufacturing sector.

[6]For example, each of the military branches has their own Manufacturing Technology Program; however, for this report, we counted only the program that oversees each of those programs and is administered by the Department of Defense's Office of Manufacturing and Industrial Base Policy.

In addition, we administered a web-based survey to the identified program officials and collected, among other data, descriptive program information, budget and participation data, information on efforts to address manufacturing trends, and performance and evaluation information. All of the categorizations of the programs in this report are based on our review of program descriptions and programs officials' responses to our survey. In developing this report, we did not conduct a legal analysis to confirm the various descriptions of the programs, including information on their budgetary obligations, program goals, or intent. Further, we did not review or analyze agencies' financial data or materials prepared by the agencies in connection with the annual budget and appropriations process.

To gather further insight into federal programs that support manufacturing, we conducted site visits to Chicago, IL and Knoxville, TN, interviewed local program officials, and visited manufacturers who participate in some of these programs. We selected these cities because several of the manufacturing programs we identified were operating there.

To identify tax expenditures that provide support to manufacturing, we reviewed relevant reports from CRS and estimates from the Department of the Treasury (Treasury) and the U.S. Congress Joint Committee on Taxation to characterize the scope and cost of tax code provisions related to manufacturing.

To identify manufacturing trends, we reviewed reports from the President's Council of Advisors on Science and Technology (PCAST) and the National Science and Technology Council (NSTC), and we spoke to seven experts about the manufacturing sector. These experts were selected for their knowledge of the manufacturing sector, and they came from nonprofit institutions such as the National Academy of Engineering, federal agencies such as the Department of Commerce (DOC) and National Science Foundation, private companies such as Palo Alto Research Center, and think tanks such as the Information Technology and Innovation Foundation. We also collected data through our survey about how federal programs are responding to trends in the manufacturing sector.

To examine the extent to which federal agencies measure their performance and assess their effectiveness in support of manufacturing generally and advanced manufacturing specifically, we asked program officials in our survey what manufacturing-related performance goals and metrics they used and what program evaluations had been conducted or

planned in the past 5 years to assess any impact that the program had on the U.S. manufacturing sector. We also analyzed efforts to coordinate federal advanced manufacturing support by reviewing relevant federal legislation, prior GAO reports on interagency collaboration, and by interviewing officials with the Office of Science and Technology Policy (OSTP). Appendix I contains additional information about our scope and methodology.

We conducted this performance audit from March 2015 to March 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The United States Manufacturing Sector

The Automobile Industry

The automobile industry affects industries that manufacture steel, glass, plastics, and rubber. The sector also supports the refining and selling of gasoline and road construction, as well as maintaining, repairing, and selling motor vehicles. In 2008, the automobile sector employed 1.7 million people in the United States, according to the Center for Automotive Research. Employment in the automobile sector reaches beyond manufacturing, including 686,000 people employed by the automotive parts sector and 737,000 salespeople and service repair professionals at auto dealers. Further, the 1.7 million direct jobs contributed to an estimated 8 million total private sector jobs accounting for more than $500 billion in annual compensation and more than $70 billion in personal tax revenues, according to the Center for Automotive Research.

Source: GAO summary of information from the Department of Commerce, the Bureau of Labor Statistics, Case Western Reserve University, and the Center for Automotive Research. I GAO-17-240

Manufacturing plays a key role in creating high-wage jobs, fueling exports, and driving innovation. In 2015, according to the Bureau of Labor Statistics (BLS), manufacturing employees earned on average $74,785 annually, including pay and benefits, while workers in all U.S. industries earned on average $63,045.[7] Manufacturing companies have also traditionally hired more employees with lower levels of education than other parts of the economy, according to the Economic Policy Institute,[8] making these companies an option for individuals whose job choices may be limited by higher education degree requirements.

Also in 2015, manufacturing firms shipped $1.3 trillion of goods abroad, according to DOC. In addition, the sector supported the development of new technologies in the United States by performing 75 percent of private sector research and development (R&D) and issuing the vast majority of new patents, despite the fact that manufacturing made up 12 percent of U.S. Gross Domestic Product (GDP) in 2014, according to the Executive Office of the President.[9] The influence of the manufacturing sector reaches many industries, as demonstrated by the automobile industry, which can be viewed as a barometer and beneficiary of American growth and economic achievement, according to BLS (see text box).

Manufacturing Economic Performance

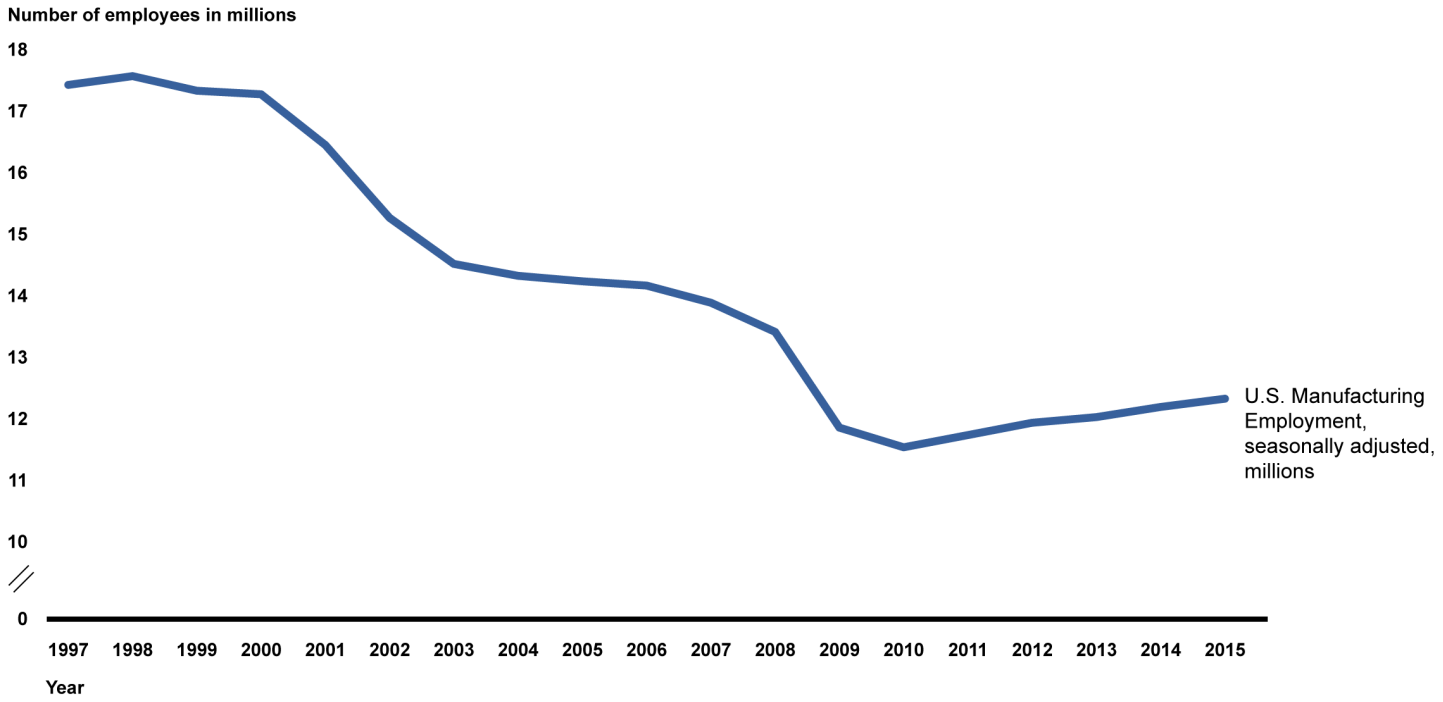
The size of the workforce in U.S. manufacturing decreased from more than 17 million employees in 1997 to approximately 12 million in 2015, according to BLS data (see fig. 1). The recent decline in manufacturing employment included sectors such as apparel, computers and electronics, and furniture, according to CRS.

[7]The comparison of average earnings may vary across the two groups depending on hours worked per week and weeks worked per year.

[8]The Economic Policy Institute is a nonprofit, nonpartisan think tank that was created in 1986 that undertakes research addressing the economic needs of low- and middle-income workers.

[9]The Executive Office of the President, “Making in America: U.S. Manufacturing Entrepreneurship and Innovation,” (June 2014).

Figure 1: Number of U.S. Manufacturing Employees 1997-2015

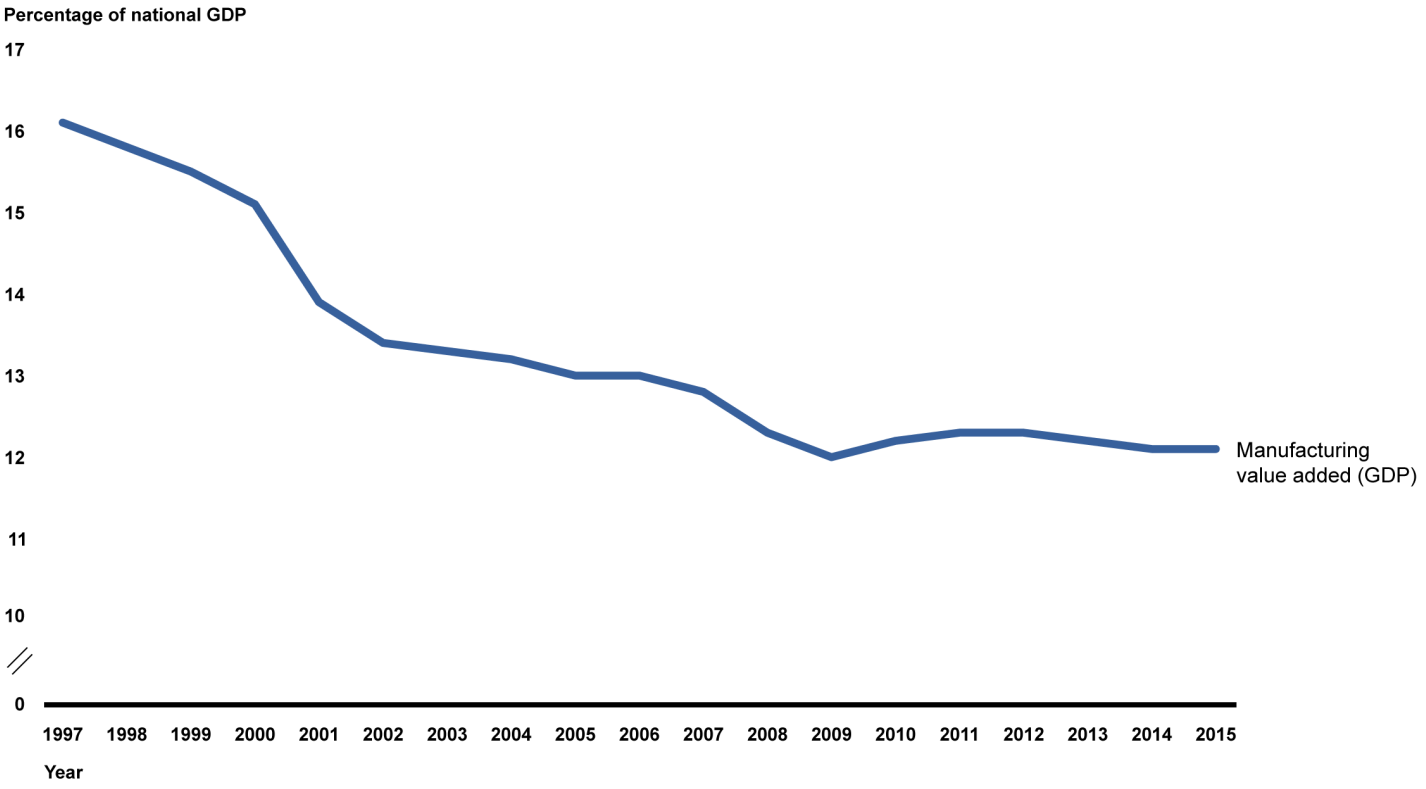


Source: GAO analysis of Bureau of Labor Statistics data. | GAO-17-240

Note: Data used in calculations are the average monthly employment numbers for each year.

Manufacturing's share of U.S. economic output has decreased over the last decade as well, according to Bureau of Economic Analysis data. As a fraction of U.S. GDP, manufacturing declined from 16.1 percent in 1997 to 12.1 percent by 2015 (see fig. 2).

Figure 2: Manufacturing Gross Domestic Product (GDP) as a Percentage Share of National GDP, 1997-2015



Source: GAO analysis of Bureau of Economic Analysis data. | GAO-17-240

Note: The figure uses nominal manufacturing value added as a percentage of nominal GDP. If real values were used, it would result in a smaller decline over the same period of time. The difference between these two perspectives is due to the rapid fall in the quality-adjusted relative price of manufacturing output, which in turn is almost entirely driven by the fall in the quality-adjusted prices of computers and electronic products, according to Martin Neil Baily and Barry P. Bosworth, "US Manufacturing: Understanding Its Past and Its Potential Future," Journal of Economic Perspectives, vol. 28, no. 1 (2014).

Role of the Federal Government

There are a number of roles that the federal government plays and a variety of tools that it uses to influence the manufacturing sector and the broader economy, including:

- **Providing funds.** The federal government funds programs that support manufacturing in different ways, such as by providing grants or awarding contracts.

- **Assuming risk.** The federal government assumes risk (and potential costs associated with risk) by making direct loans, guaranteeing loans, and providing insurance.
- **Collecting or forgoing revenue from taxes.** The federal government collects revenues through the tax system, and forgoes revenues through tax expenditures such as exemptions, deductions, credits, and deferrals, as well as preferential tax rates.
- **Directly procuring goods and providing services.** The federal government procures manufactured products, such as weapons systems, and provides services, such as technical assistance, directly through government agencies.
- **Setting standards and requirements.** Federal laws and regulations also set standards and requirements that can influence manufacturing activities. Standards, like energy, environmental, and workplace safety standards, can help to enhance the societal benefits of manufacturing, but they may also affect the costs related to manufacturing.

In some cases, the tools the federal government uses to influence the manufacturing sector are applied directly, such as in the case of a grant provided to a specific company. In other cases, the federal government influences the manufacturing sector in a more indirect way. For example, the federal government delivers tools and technical assistance that manufacturers use to help invent, innovate, and create new products and services. Specifically, the mission of DOC's National Institute of Standards and Technology (NIST) is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve quality of life. As part of this mission, NIST administers measurement science research programs across five laboratories and two national user facilities, which provide industry with precision measurement technologies, tests, protocols, and scientific and engineering knowledge, according to NIST officials. The outputs of the NIST laboratories include scientific data and methods that are used in the processes, products, and services of nearly every U.S. manufacturing

industry, as well as the national service sector, according to agency officials.[10]

The federal government established advisory groups and an office that promote coordination across federal agencies and programs to better support manufacturers. In recent years, these groups have made recommendations, formed partnerships, and developed a strategic plan for advanced manufacturing. For example:

- The Manufacturing Council, established in 2004, serves as the principal private sector advisory committee to the Secretary of Commerce on the U.S. manufacturing sector. It typically meets several times a year and develops recommendations for the Secretary of Commerce.
- The America COMPETES Reauthorization Act of 2010 (COMPETES Act) called for a committee to plan and coordinate federal programs and activities in advanced manufacturing R&D, and NSTC designated the Committee on Technology to take on this task.[11] The COMPETES Act required this committee to (1) develop a strategic plan for advanced manufacturing, (2) update the plan every 5 years, and (3) specify and prioritize near-term and long-term R&D objectives, the anticipated time frame for achieving the objectives, and the metrics for use in assessing progress toward the objectives, among other things.
- In 2011, PCAST recommended that the federal government work to better coordinate efforts to support advanced manufacturing, among

[10]While the National Institute of Standards and Technology's (NIST) work is particularly important to manufacturers who may rely on NIST-backed measurements to ensure their products meet specific standards, we did not include NIST's laboratory research efforts in the scope of our review because it did not meet our criteria as a program with a specific focus on manufacturing.

[11]The National Science and Technology Council (NSTC) was established by executive order on November 23, 1993. Exec. Order No. 12,881, 58 Fed. Reg. 62,491 (Nov. 26, 1993). This cabinet-level council is the principal means within the executive branch to coordinate science and technology policy across the diverse entities that make up the federal research and development enterprise. A primary objective of the NSTC is establishing clear national goals for federal science and technology investments spanning virtually all the mission areas of the executive branch. The NSTC's work is organized under five committees: (1) Environment, Natural Resources, and Sustainability; (2) Homeland and National Security; (3) Science, Technology, Engineering, and Math Education; (4) Science; and (5) Technology. Each of these committees oversees subcommittees and working groups focused on different aspects of science and technology.

other things.[12] In general, advanced manufacturing includes activities that depend on the use and coordination of information, automation, computation, software, sensing, and networking. Or advanced manufacturing can use cutting edge materials and emerging capabilities enabled by the physical and biological sciences.

- In 2011, DOC established the Advanced Manufacturing National Program Office, which is designed to support public-private partnerships to increase advanced manufacturing.[13]
- In 2012, OSTP published the National Strategic Plan for Advanced Manufacturing with five objectives: (1) accelerating investment in advanced manufacturing technology; (2) expanding the number of workers with the skills needed by a growing advanced manufacturing sector and making education and training systems more responsive; (3) creating and supporting national and regional public-private partnerships among government, academia, and the private sector; (4) taking a portfolio perspective and coordinating investments across agencies; and (5) increasing total U.S. public and private investment in advanced manufacturing R&D.[14]
- In 2014, the Revitalize American Manufacturing and Innovation Act of 2014 (RAMI Act) was enacted as part of the Consolidated and Further Continuing Appropriations Act, 2015. The RAMI Act amended the requirements for the strategic plan for advanced manufacturing to say that the Committee on Technology shall develop, and update as required, a strategic plan to improve government coordination and provide long-term guidance for federal programs and activities in support of U.S. manufacturing competitiveness, including advanced manufacturing R&D. The RAMI Act also requires that the strategic plan describe the progress made in achieving the objectives from prior strategic plans, including a discussion of why specific objectives were not met. The next update of the strategic plan is due by May 1, 2018.

[12]PCAST is an advisory group of scientists and engineers, appointed by the President to make policy recommendations on science, technology, and innovation to the White House.

[13]This office is also referred to as the National Program Office.

[14]The strategic plan was developed by an NSTC interagency working group. According to the plan, it responded to the America COMPETES Reauthorization Act of 2010 requirement to develop a strategic plan to guide federal programs and activities in support of advanced manufacturing research and development.

- In 2015, NSTC's Committee on Technology reestablished a Subcommittee on Advanced Manufacturing (SAM) to identify gaps in the federal advanced manufacturing R&D portfolio and policies, identify and evaluate policies and programs that support technology commercialization, and identify and promote opportunities for public-private collaboration, among other things. The SAM's scope includes support for implementation of recommendations from PCAST as well as support for implementation of and updates to the national strategic plan for advanced manufacturing. According to the SAM's charter, it was previously known as the Advanced Manufacturing Subcommittee. The SAM's charter expired on March 1, 2017, and has not been renewed by the Chair of the Committee on Technology.[15]

Selected Federal Programs Reported Supporting U.S. Manufacturing by Fostering Innovation, Strengthening Competitiveness in the Global Marketplace, and Assisting Workers

Federal Programs We Identified Reported Supporting U.S. Manufacturing

We identified 58 programs in 11 federal agencies that reported they support U.S. manufacturing. Based on our review of survey responses, these programs support manufacturing by fostering innovation, helping manufacturers compete in the global marketplace, helping workers enhance skills and obtain employment, and providing general financing or general business assistance. All of the categorizations of the programs in this report are based on our review of program officials' responses to our

[15]According to OSTP's General Counsel, as of mid-March 2017, OSTP was working on extending the charter. For that reason, we continue to refer to the Subcommittee on Advanced Manufacturing (SAM) and its previous charter throughout the report.

survey.[16] Most of the manufacturing-related programs we identified are administered by the Departments of Commerce, Defense, Energy, or the National Science Foundation (see table 1).

Table 1: Programs GAO Identified That Reported They Support U.S. Manufacturing, by Agency

Department of Agriculture	**Department of Health and Human Services**
Bioenergy Program for Advanced Biofuels	Centers for Innovation in Advanced Development and Manufacturing
Business and Industry Guaranteed Loan Program	Fill Finish Manufacturing Network
	National Occupational Research Agenda Manufacturing Sector Program

Department of Commerce	
Advocacy Center	**Department of Labor**
Antidumping and Countervailing Duty Operations	H-1B Technical Skills Training Grant Program
Domestic Field	Registered Apprenticeship Program
Foreign-Trade Zones in the United States	Trade Adjustment Assistance
Hollings Manufacturing Extension Partnership	Trade Adjustment Assistance Community College and Career Training Grant
Industry Trade Policy and Analysis	
International Field	**Environmental Protection Agency**
Investing in Manufacturing Communities Partnership	E3-Economy, Energy, and Environment
Manufacturing	
Manufacturing USA[a]	**Export-Import Bank**
Textiles, Consumer Goods, and Materials	Export-Import Bank of the United States
Trade Adjustment Assistance for Firms	
Trade Enforcement and Compliance Policy and Negotiations	**National Science Foundation**
	Advanced Technological Education Program
Department of Defense	Biotechnology and Biochemical Engineering
Basic, Applied, and Advanced Research in Science and Engineering	Design of Engineering Materials Systems
Commercial Technologies for Maintenance Activities	Engineering and Systems Design
Defense Production Act Title III	Industry/University Cooperative Research Centers Program
Industrial Base Analysis and Sustainment Program	Manufacturing Machines and Equipment

[16]We did not conduct a legal analysis to confirm the various descriptions of the programs in this report, including information on their budgetary obligations, program goals, or intent. Further, we did not review or analyze agencies' financial data or materials prepared by the agencies in connection with the annual budget and appropriations process.

Manufacturing Applied Research	Materials Engineering and Processing
Manufacturing Experimentation and Outreach Two	Nanomanufacturing
Manufacturing Technology Program	National Robotics Initiative
Navy Manufacturing Science	Service, Manufacturing and Operations Research
Prototype Integration Facilities	
	Small Business Administration
Department of Education	7(a) Loan Program
Career and Technical Education – Basic Grants to States	Certified Development Company (CDC)/504 Loan Program
Career and Technical Education – National Programs	Small Business Innovation Research
	Small Business Technology Transfer
Department of Energy	
Advanced Manufacturing Office	
Advanced Technology Vehicles Manufacturing Loan Program	
Bioenergy Technologies Office	
Clean Energy Manufacturing Initiative	
Concentrating Solar Power	
Photovoltaics	
Solid State Lighting Program	
Tech-to-Market	
Windows & Building Envelope	

Source: GAO survey of agency officials. | GAO-17-240

[a]Manufacturing USA is also known as the National Network for Manufacturing Innovation program. On September 12, 2016, the Secretary of Commerce announced Manufacturing USA as the new public name for the program.

The 58 programs we identified that support manufacturing obligate varying amounts of funds. (See app. II for a full list and description of these programs, including obligation amounts for 2014-16 and estimated proportions of these obligations used to support U.S. manufacturing.)[17] In some cases, agency officials were able to estimate for our survey the amount of funds that supported manufacturing because they considered the entire program to be supporting manufacturing. In other cases, officials did not estimate the amount their programs obligated to support U.S. manufacturing, and instead they provided us with a range. Officials with 21 programs reported that 100 percent of their program's obligations

[17]Additional programs may support U.S. manufacturing in other ways, but if we did not identify any specific focus on manufacturing through our review of program descriptions and interviews with agency officials, we did not select them. See appendix I for a description of our methodology for selecting these programs.

were used to support manufacturing. Reported obligations for these programs ranged from $750,000 to $203,568,000 in fiscal year 2015.[18] For example, the National Science Foundation's (NSF) Nanomanufacturing program provides grants that support fundamental research that may lead to the production of useful nano-scale materials, structures, devices, and systems. According to our survey, the program obligated $8,912,533 in fiscal year 2015, and agency officials estimated that all of the obligations supported U.S. manufacturing.

Twenty-six other programs reported using funding to support manufacturing—in additional to other sectors—and provided ranges of estimates for the obligations directly supporting manufacturing.[19] For example, agency officials told us the Department of Labor's (DOL) Registered Apprenticeship Program prepares American workers to compete in a global 21st century economy by training millions of them through a network of 21,000 Registered Apprenticeship programs consisting of over 150,000 employers. Also according to agency officials, the program obligated $34,000,000 in fiscal year 2015, and because manufacturing programs make up approximately 20 percent of all Registered Apprenticeship programs managed by federal staff, they estimated that between 10 and 20 percent of federal staff resources are used to assist with the establishment of new manufacturing programs and to support existing manufacturing programs. The remaining 11 programs either did not provide an estimate of their support to manufacturing or reported zero program obligations in fiscal year 2015. Table 2 indicates the obligations, by agency, for the 58 programs reported by agency officials.

[18]Three of these 21 programs did not report the amount of their obligations for fiscal year 2015. In some cases, agency officials may have estimated or rounded their program's obligations for our survey. See appendix I for the steps we took to assess the reliability of these data.

[19]Two of these programs reported zero percent of their obligations in fiscal year 2015 to support U.S. manufacturing.

Table 2: Reported Fiscal Year 2015 Obligations for 58 Programs That Reported Supporting U.S. Manufacturing

Agency	Programs that reported supporting U.S. manufacturing	Reported total program obligations, in millions[a]
Small Business Administration	4	$2,549
Department of Education	2	$1,123
Department of Agriculture	2	$1,059
Department of Labor	4	$791
Department of Energy	9	$452[b]
Department of Defense	9	$411[c]
Department of Commerce	13	$377[c]
Department of Health and Human Services	3	$330
National Science Foundation	10	$180
Export-Import Bank	1	$107[d]
Environmental Protection Agency	1	$4

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the total obligations reported for these programs, and include activities that support manufacturing as well as all other activities.

[b]Department of Energy officials reported $17 million in additional obligations in fiscal year 2015 on Space Conditioning and Refrigeration research and development. We did not survey that program as a part of this review.

[c]This number does not include obligations for some of these programs because agency officials did not provide this information.

[d]This amount represents the amount obligated by the Export-Import Bank for administrative costs, which according to the Bank were paid by the fees charged to the foreign buyers of U.S. exports.

Thirty Programs We Identified Reported They Help Foster Innovation by Supporting Basic and Applied Research and Development

Among the 58 programs we identified, 30 fostered innovation through their support for basic and applied R&D, based on our analysis of survey responses.[20] (See table 3.) Advocates of targeted innovation policy argue that it is important because the manufacturing sector depends on continually creating new ideas for products and strategies.

[20]In addition to these programs, Department of Commerce (DOC) officials noted that NIST supports advanced manufacturing research and development (R&D) through its national laboratories. According to DOC officials, NIST spent $139 million in fiscal year 2015 on measurement science R&D supporting advanced manufacturing. We did not survey these national laboratories as a part of this review.

Table 3: Reported Fiscal Year 2015 Obligations for 30 Programs GAO Identified That Help Foster Innovation

Agency	Programs that help foster innovation	Reported total program obligations, in millions[a]
Small Business Administration	2	$2,549
Department of Energy	8	$449[b]
Department of Health and Human Services	1	$297
Department of Defense	7	$207[c]
Department of Commerce	2	$145
National Science Foundation	9	$115
Environmental Protection Agency	1	$4

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the total obligations reported for these programs, and include activities that support manufacturing as well as all other activities.

[b]Department of Energy officials reported $17 million in additional obligations in fiscal year 2015 on Space Conditioning and Refrigeration research and development. We did not survey that program as a part of this review.

[c]This number does not include obligations for some programs because agency officials did not provide this information.

Supporting basic R&D by providing grants to educational institutions and others. Ten of the 30 programs support basic R&D—that is, research that is conducted without a specific commercial application but which may spur private sector innovation—based on our analysis of survey responses. The public sector, through government scientific agencies, public universities, and other research institutions, may be well-suited to support basic R&D, as we reported in our July 2013 report on global manufacturing.[21] Basic R&D supports innovation by creating opportunities for technological advances, according to the National Strategic Plan for Advanced Manufacturing.[22]

- Eight of the 10 programs that seek to support basic R&D are directed by NSF. For example, the Design of Engineering Material Systems program seeks to support research to inform the accelerated design

[21]GAO, *Global Manufacturing: Foreign Government Programs Differ in Some Key Respects from Those in the United States*, GAO-13-365 (Washington, D.C.: July 25, 2013).

[22]Executive Office of the President, NSTC, *A National Strategic Plan for Advanced Manufacturing*, (Washington D.C.: February 2012).

and development of materials that can be used in manufacturing processes. In fiscal year 2015, this program obligated $3,223,434, according to agency officials, and provided grants to approximately 12 educational institutions, which supported about 140 students and other individuals conducting research.

- Another NSF program, the Manufacturing Machines and Equipment program, aims to support basic research in engineering and science that enables the development of new manufacturing machines and equipment, among other things. These machines and equipment are used to manufacture mechanical and electromechanical products. According to our survey data, in fiscal year 2015, this program obligated $10,461,608 and supported approximately 45 educational institutions and 440 students and other individuals.

Supporting applied R&D. Twenty of the 30 programs fostered innovation by supporting applied R&D—that is, research designed to solve practical problems or develop and commercialize new products—based on our analysis of survey responses. Applied R&D helps to bridge the gap between new ideas and commercially viable products or processes.[23] We visited locations where two of these programs—the Hollings Manufacturing Extension Partnership (MEP) program and the Manufacturing USA program—were operating to obtain more specific information on how they were supporting manufacturing:

- The MEP program, with reported obligations of $144,556,000 in fiscal year 2015, consists of a national network of centers located in all 50 states and Puerto Rico that seeks to help small- and medium-sized manufacturers adopt new technologies and commercialize their products. The centers are funded through a cost-sharing arrangement. In addition to federal funding from NIST, the centers receive funding from state and local governments, and from fees charged to manufacturers. Officials from the Illinois center reported they observed production processes at a local manufacturer and made suggestions to improve efficiency. For example, they identified an instance where equipment could be used to free up a worker for other purposes. Center officials also said they had plans to support local manufacturers by providing “market intelligence” or estimating how much the market would value a particular product or feature.
- The Manufacturing USA program aims to support manufacturing through applied R&D by coordinating a network of institutes where

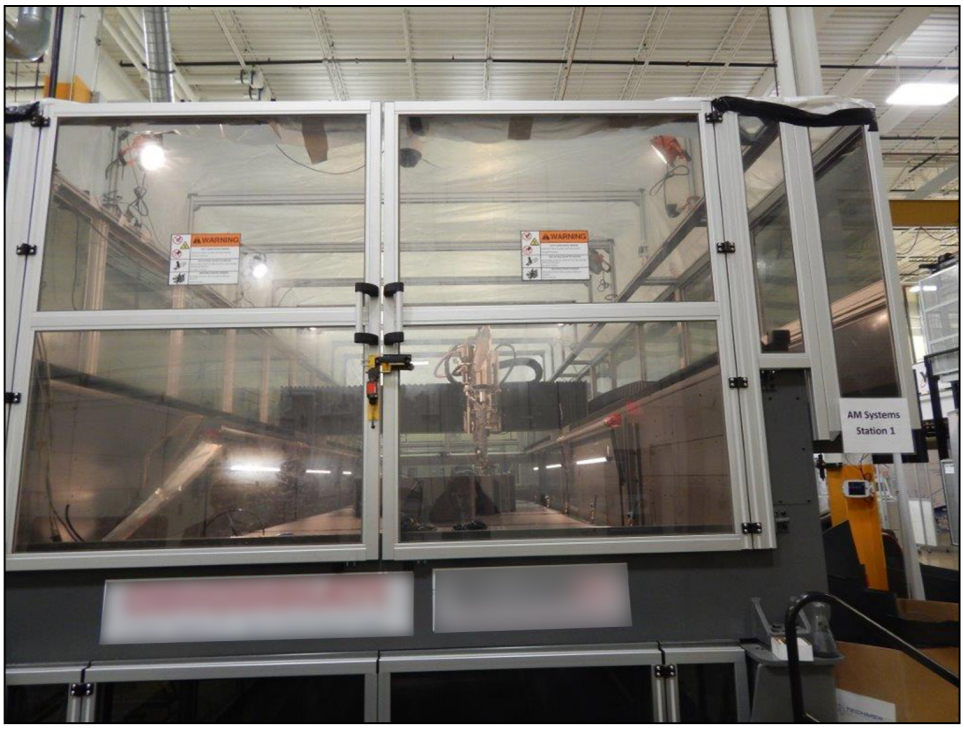
[23]GAO-13-365.

public and private sector stakeholders work together to, among other things, resolve technical barriers to innovative manufacturing technologies or processes. As of 2016, the program supported nine institutes, and five or six additional institutes will be announced in fiscal year 2017, according to agency officials. The Manufacturing USA program is overseen by DOC, and as of 2016, each institute was funded by either the Department of Defense or the Department of Energy, with other agencies planning to fund additional institutes, according to Commerce officials. The Manufacturing USA institute we visited in Knoxville, Tennessee, conducts research related to advanced composites and utilizes a manufacturing demonstration facility that conducts research on additive manufacturing (also known as three dimensional (3D) printing).[24] Officials at the institute told us that private companies may find it difficult to purchase manufacturing machines, such as 3D printers, due to their size and cost. They said that the combination of resources available through the institute and the Manufacturing Demonstration Facility allows members to use these machines at a fraction of the normal purchase cost to test or demonstrate new manufacturing technologies. (See fig. 3.) Similarly, the Manufacturing USA institute we visited in Chicago, Illinois, allows its members to use its advanced technology machines to demonstrate the benefits of digital manufacturing, which involves using an integrated computer-based system to improve manufacturing.[25] An institute official noted that allowing its members to use machines at the institute may increase the pace of R&D by allowing manufacturers to quickly create prototypes to test designs.

[24]3D printing is a layer-by-layer process of producing 3D objects directly from a digital model. Unlike conventional manufacturing processes, 3D printing creates a finished piece in successive layers, generally without using molds, casts, or patterns. As 3D printing has become more widespread, it has been used to develop tools and casts for conventional manufacturing, among other things. Additionally, 3D printing could be used to produce parts and products in fields such as medicine and aerospace. For more information, see GAO, *Highlights of a Forum: 3D Printing: Opportunities, Challenges, and Policy Implications of Additive Manufacturing,* GAO-15-505SP (Washington, D.C.: June 24, 2015).

[25]According to officials working in digital manufacturing, this technology involves use of an integrated, computer-based system comprised of simulation, three-dimensional visualization, analytics, and various collaboration tools to create product and manufacturing process definitions simultaneously.

Figure 3: 3D Printer Used in Advanced Manufacturing



This 3D printer is housed at the Department of Energy's Manufacturing Demonstration Facility at the Oak Ridge National Laboratory, which partners with the Manufacturing USA Advanced Composites Manufacturing Innovation institute in Knoxville, TN.

Source: GAO. | GAO-17-240

Eleven Programs We Identified Reported They Assist Manufacturers with Trade in the Global Marketplace

Eleven of the 58 programs assist manufacturers to trade in the global marketplace, based on our analysis of survey responses. These programs engage in activities like promoting U.S. exports and open trade, providing financial support, providing technical assistance, and enforcing trade laws and supporting policy formulation (see table 4). According to our survey data, DOC administers all but one of these programs, and they devote a majority of their resources and activities to manufacturing.

Table 4: Reported Fiscal Year 2015 Obligations for 11 Programs That Assist Manufacturers with Trade in the Global Marketplace

Agency	Programs that assist manufacturers with trade in the global marketplace	Reported total program obligations, in millions[a]
Department of Commerce	10	$233[b]
Export-Import Bank	1	$107[c]

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the total obligations reported for these programs, and include activities that support manufacturing as well as all other activities.

[b]This number does not include obligations for some programs because agency officials did not provide this information.

[c]This represents the amount obligated by the Export-Import Bank for administrative costs, which according to the Bank were paid by the fees charged to the foreign buyers of U.S. exports.

Promoting U.S. exports. Export promotion programs can assist U.S. companies with trade in the global marketplace by helping them overcome barriers to entry in foreign markets, as we have previously reported.[26] Of the 11 programs we identified that help manufacturers with trade in the global marketplace, 6 reported promoting U.S. exports. For example, 1 of these 6 programs, DOC's Domestic Field program, reported providing services in partnership with the Export-Import Bank and the Small Business Administration (SBA), through a network of U.S. Export Assistance Centers. These centers seek to provide customized assistance to local small-and medium-sized companies, including manufacturers, by helping to identify relevant partners and markets and by assisting with export mechanics and financing options, according to program officials. With 108 offices in 48 states and Puerto Rico, these centers served about 25,000 businesses in fiscal year 2015, according to agency officials. We visited a center located in Knoxville, Tennessee, which, according to local officials, worked with a company to create an outreach seminar and develop an invitation list for it in Mexico. According to local officials, the seminar helped increase the company's sales of manufactured medical products to Mexico. The Knoxville center also seeks to assist local companies with the export process by helping to locate distributors for their products, according to local officials.

[26]GAO, *International Trade: Observations on U.S. and Foreign Countries' Export Promotion Activities,* GAO-10-310T (Washington, D.C.: Dec. 9, 2009).

Providing financial support. Based on our survey, 2 of the 11 programs we identified provide various types of financial support to companies or their customers that are unable to obtain financing from the private sector or have been affected by import competition. For example, according to the Export-Import Bank, it supports companies by using three main types of financial products:

- fixed-rate loans directly to foreign buyers of U.S. goods and services;
- loan guarantees to commercial lenders to cover repayment risks on foreign buyers' debt obligations incurred to purchase U.S. exports; and
- export credit insurance, which supports U.S. exporters selling goods overseas by protecting them against the risk of foreign buyer or other foreign debtor default.

According to the Export-Import Bank's fiscal year 2015 annual report, the Bank authorized 41 loans and 344 loan guarantees, in a range of sectors, including, but not limited to, manufacturing. In one instance, the Export-Import Bank guaranteed commercial loans to support the export of bridges manufactured by a U.S.-based company. According to the Export-Import Bank, these guarantees allowed the manufacturer to gain entry into foreign markets, and they also supported jobs in the United States.

Another program we surveyed that seeks to provide financial support, among other things, is the Trade Adjustment Assistance for Firms program, which is administered by DOC. According to our survey, the program supports a network of trade adjustment assistance centers that work with manufacturers that have been affected by competition from imported products. These centers aim to help manufacturers develop and implement business recovery plans, among other things, and provide matching funds for consultants to work with manufacturers to implement projects in business recovery plans, according to agency officials.

Enforcing trade laws and agreements and supporting policy formulation. Based on our analysis of survey responses, DOC administers three programs that enforce trade agreements and support policy formulation and negotiations. One of the three programs, the Industry Trade Policy and Analysis program, seeks to provide analysis and expertise to conduct policy formulation or represent industry members in trade negotiations. These activities aim to help expand exports and bolster foreign direct investments in the United States, which can assist many industries,

including manufacturing. Another program, the Trade Enforcement and Compliance Policy and Negotiations program, oversees policies and programs related to the negotiation of and pursuing foreign compliance with trade and investment disciplines in international agreements, the administration of U.S. antidumping and countervailing duty laws, and the negotiation and administration of suspension agreements of U.S. antidumping and countervailing duty investigations. The Antidumping and Countervailing Duty Operations program investigates if petitions provide sufficient evidence that dumping or unfair subsidization is occurring.[27] Generally, if the results of an investigation indicate that goods are being dumped or unfairly subsidized, and the U.S. International Trade Commission determines that U.S. industry is being injured, DOC will issue an order requiring importers subject to the order to make cash deposits equal to the amount of dumping and/or subsidization found. Later, Antidumping and Countervailing Duty Operations program officials might conduct an administrative review to determine the actual amount of dumping or subsidization and calculate a final duty rate.[28] According to our analysis of the survey, these activities help manufacturers by promoting fair competition in the marketplace, and by ensuring that U.S. firms are not adversely affected by actions of foreign producers and governments. The Antidumping and Countervailing Duty Operations program reported that it assisted at least 440 U.S. companies and unions in fiscal year 2015. According to agency officials we surveyed, other U.S. manufacturing companies also may have benefited from actions taken by the program. For example, as we found in 2013, trade remedy duties, such as those determined by the Antidumping and Countervailing Duty Operations program, add to the price of foreign products imported into the United States, and they can benefit domestic producers of these products regardless of whether the producers file a petition.[29]

[27]Under U.S. law, firms can file a petition to request the U.S. government investigate when they believe they have been adversely affected by dumping or exports subsidized by a countervailable subsidy from other countries into the United States.

[28]U.S. Customs and Border Protection collects the duty amount owed. For more information, see GAO, *Antidumping and Countervailing Duties: CBP Action Needed to Reduce Duty Processing Errors and Mitigate Nonpayment Risk,* GAO-16-542 (Washington, D.C.: July 14, 2016).

[29]GAO, *Antidumping and Countervailing Duties: Key Challenges to Small and Medium-Sized Enterprises' Pursuit of the Imposition of Trade Remedies,* GAO-13-575 (Washington, D.C.: June 25, 2013).

Eight Programs We Identified Reported They Help Job Seekers Enhance Skills and Obtain Employment

Of the 58 programs, we identified 8 in the training policy area that help job seekers enhance skills and obtain employment, based on our analysis of survey responses. (See table 5). Some of these programs help job seekers bolster their skills in response to technological advances in the manufacturing sector, while others help job seekers find reemployment when laid off from their manufacturing jobs. Most training programs we identified are administered by the Departments of Labor and Education, and while manufacturing workers may be eligible for such training, the programs generally address workforce changes across many sectors of the economy.

Table 5: Reported Fiscal Year 2015 Obligations for Eight Programs That Help Job Seekers Enhance Skills and Obtain Employment

Agency	Programs that help job seekers enhance skills and obtain employment	Reported total program obligations, in millions[a]
Department of Education	2	$1,123
Department of Labor	4	$791
National Science Foundation	1	$65
Department of Defense	1	Not reported[b]

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the total obligations reported for these programs, and include activities that support manufacturing as well as all other activities.

[b]Agency officials did not provide obligations information.

Supporting the enhancement of job seekers' skills. Seven of the eight programs help job seekers enhance job skills, based on our analysis of survey responses. For example, one program, the Trade Adjustment Assistance Community College and Career Training Grant (TAACCCT) program, provided multi-year grants to universities and community colleges to support education and career training programs that aim to help job seekers bolster their skills and obtain employment in higher skilled jobs. This program is administered by the Department of Labor (DOL) and implemented in partnership with the Department of Education (Education), and while it currently oversees existing grants, it has stopped providing new grant funding. In fiscal year 2014, the program obligated $463,994,493, according to agency officials. Community colleges use these grants to develop workforce training programs that are aligned with the needs of local industry. The grants are also used to develop workforce training programs that prepare job seekers for employment in a range of industries, and many community colleges identified

manufacturing as a significant industry in their area, according to responses made by agency officials in our survey. For example, an official from a network of community colleges we visited in Illinois that received a TAACCCT grant said that the grant served as a catalyst for discussions between local manufacturers and community colleges. According to this official, these discussions helped community colleges identify topics to include in their curriculum and the skillsets required in the manufacturing sector, and as a result, the grant aimed to ensure that job seekers are adequately prepared for employment in the manufacturing sector.

Providing support for job seekers who have been laid off from their job in the manufacturing sector. One of the eight programs, the Trade Adjustment Assistance (TAA) program, administered by DOL, provides benefits and employment services for job seekers who have lost their jobs due to global trade, based on our analysis of the survey. According to information provided by agency officials in our survey, job seekers are eligible to participate in the TAA program if they have been adversely affected by increased imports or a shift in production to other countries, among other factors. Job seekers in the TAA program can receive a skills assessment, training, and individual career counseling, among other things, to help train them for new jobs in fields that may require advanced skills. In fiscal year 2015, states obligated $507 million to serve TAA-eligible workers in all industry sectors, according to DOL. Although funding was not targeted specifically for the manufacturing sector, agency officials estimated that approximately 86 percent of certified workers in fiscal year 2015 were from the manufacturing sector. Although most job seekers obtain employment in other sectors after participating in the TAA program, DOL officials reported that about 4,500 job seekers were reemployed in the manufacturing sector after participating in the TAA program in fiscal year 2015.

Nine Programs We Identified Reported They Support Manufacturing by Providing General Financing or General Business Assistance or by Developing Manufactured Products

We identified nine programs that provide general financing or general business assistance that cuts across all three policy areas (innovation, trade, and training) or that support the manufacturing of public health products, based on our analysis of survey responses (see table 6). Some of these programs provide general financing through loans or loan guarantees to businesses in all sectors, including manufacturing, or provide direct payments to specific manufacturing industries, such as defense and bioenergy.[30] A few programs also assist the health care sector by supporting the manufacturing of public health products.

Table 6: Reported Fiscal Year 2015 Obligations for Nine Programs That Support Manufacturing by Providing General Financing or General Business Assistance or by Developing Manufactured Products

Agency	Programs that support manufacturing by providing general financing, general business assistance, or developing specific manufactured products	Reported total program obligations, in millions[a]
Department of Agriculture	2	$1,059
Department of Defense	1	$204
Department of Health and Human Services	2	$33
Department of Energy	1	$4
Department of Commerce	1	Not reported[b]
Small Business Administration	2	Not reported[b]

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the total obligations reported for these programs, and include activities that support manufacturing as well as all other activities.

[b]Agency officials did not provide obligations information.

Providing general financing. Six of the nine programs we identified support manufacturing by providing various types of general financing, including loans, loan guarantees, or direct payments, based on our analysis of survey responses. For example, according to the survey, the Department of Agriculture's Business and Industry Guaranteed Loan Program, the SBA's 7(a) and Certified Development Company (CDC)/504

[30]According to the U.S. Department of Agriculture, bioenergy is a type of renewable energy that is derived from biological sources. Bioenergy can be used for a variety of purposes, including heat, electricity, or vehicle fuel.

Loan programs, and the Department of Energy's Advanced Technology Vehicles Manufacturing Loan program provide loans or loan guarantees but each agency targets different types of manufacturers and has different eligibility requirements. The Business and Industry Guaranteed Loan Program generally supports rural businesses by issuing loan guarantees, while both SBA programs generally provide loan guarantees to eligible small businesses to finance a wide range of needs, including working capital, revolving credit, asset acquisition, and re-financing. Further, the Advanced Technology Vehicles Manufacturing Loan program supports the manufacturing of advanced technology vehicles by providing direct loans to automotive and component manufacturers.

In addition to providing loans or loan guarantees to assist manufacturers, the Defense Production Act Title III program, for example, provides direct payments to manufacturers by purchasing advanced materials and technologies that develop their production capabilities. According to our survey, the program obligated $203,568,000 in fiscal year 2015, all of which supported U.S. manufacturing. Another program, the Bioenergy Program for Advanced Biofuels, supports the production of advanced biofuels by providing payments to advanced biofuel producers.[31] In fiscal year 2015, the program provided payments to 225 manufacturers, according to our survey data.

Providing general support to manufacturing across the areas of innovation, trade, and training. We identified one program—the Investing in Manufacturing Communities Partnership (IMCP) program—that supports manufacturing by cutting across all three policy areas. Based on our survey, as of calendar year 2015, the IMCP program had designated 24 locations across the country as manufacturing communities through a competitive selection process.[32] As part of the IMCP program, locations designated as manufacturing communities receive technical assistance from 12 federal agencies—in addition to DOC—and are eligible for preferential consideration for funding consistent with each agency's program eligibility requirements and evaluation criteria, according to DOC. According to program officials we met with in Knoxville, an advantage of being designated a manufacturing community is the

[31]Advanced biofuels are fuels produced from renewable biomass excluding corn kernel starch.

[32]According to agency officials we surveyed, manufacturing communities may include multiple counties and cross state borders.

increased level of collaboration among federal, state, and regional stakeholders, which has helped create new business opportunities, attract businesses to the region, and provide manufacturing training to workers. The IMCP community we visited in Chicago focuses on metal manufacturing, and its members collaborate with other organizations to provide such training to workers.[33] For instance, the Jane Addams Resource Corporation, a training provider, administers a training curriculum that addresses the specific skills required for employment in the manufacturing sector. Officials told us that they provide students with hands-on training and adjusted their training curriculum to match industry trends. For instance, they said that they acquired a robotic welder and used it to train their students on this new, automated technology (see fig. 4).

[33]One of the members of the Investing in Manufacturing Communities Partnership (IMCP) in Chicago, IL, is the Chicago Cook Workforce Partnership. According to local program officials, this partnership works with a variety of organizations to provide training to workers, including the Jane Addams Resource Corporation, which is funded by programs authorized by the Workforce Innovation and Opportunity Act.

Figure 4: Welding Machine Used For Training

In order to accommodate increasingly automated technologies in manufacturing, the Jane Addams Resource Corporation acquired this robotic welder, which can be programmed to handle parts and weld. This welding machine is used to teach welding techniques to students in JARC's training program.

Source: GAO. | GAO-17-240

Supporting the manufacturing of public health products. Two of the nine programs we identified support the development, acquisition, and testing of public health supplies, according to our analysis of survey responses. The Department of Health and Human Services (HHS) awarded contracts to establish the Centers for Innovation in Advanced Development and Manufacturing, which is composed of three manufacturing organizations. These organizations develop and manufacture medical countermeasures, such as influenza vaccines and protections against chemical, biological, radiological and nuclear threats. Contractors for another program, the Fill Finish Manufacturing Network, provide packaging support for medical countermeasure products. Among other things, HHS has engaged with the Fill Finish Manufacturing Network to transfer sterile drug products that would be required in a public health emergency, according to our survey data.

Selected Federal Tax Expenditures Can Provide Benefits to Manufacturers but Their Overall Effects Are Difficult to Quantify

Tax Expenditures

Tax expenditures are reductions in an individual or corporate taxpayer's tax liability that are the result of special exemptions and exclusions from taxation, deductions, credits, deferrals of tax liability, or preferential tax rates. They often aim to achieve policy goals similar to those of federal spending programs.

Source: GAO-13-167SP. | GAO-17-240

Nine tax expenditures provide benefits to manufacturers, according to a CRS report and Treasury officials.[34] These tax expenditures provide incentives to manufacturers through tax deductions, deferral, credits, and other methods. These tax expenditures are available to manufacturers, as well as other corporations or individual taxpayers that meet the qualifying requirements. (See table 7.)

Table 7: Selected Federal Tax Expenditures That Can Support Manufacturing

Tax expenditures	Estimated forgone revenue, including manufacturing and other sectors (millions) FY 2015
Deferral of active income of controlled foreign corporations	$99,300
Accelerated depreciation for certain capital assets, including bonus depreciation	$90,600 (FY 2016 estimate)[a]
Deduction for qualified domestic production activities	$16,200
Research and experimentation tax credit	$8,300 (FY 2016 estimate)[a]
Expensing of research and experimental expenditures	$4,800
Option to claim a refundable accelerated alternative minimum tax credit in lieu of bonus depreciation allowance	$2,500 (FY 2016 estimate)[a]
Inventory accounting: use of the last-in, first-out method	$1,800
Inventory property sales source rule exception	$1,700
Partial exclusion on gains from the sale or exchange of qualified small business stock	$900

Source: Joint Committee on Taxation

[34]These tax expenditures and their descriptions were compiled by the Congressional Research Service in the 2013 report, *Federal Tax Benefits for Manufacturing: Current Law, Legislation in the 113th Congress, and Arguments For and Against Federal Assistance*. We conferred with officials from the Department of the Treasury (Treasury), who agreed that these expenditures have an impact on the manufacturing sector. However, these expenditures are not necessarily a comprehensive representation of tax incentives that support the manufacturing sector because other tax incentives that benefit businesses in general may also benefit manufacturers to some degree.

[a]The Joint Committee on Taxation (JCT) report did not estimate forgone revenue for these tax expenditures for FY 2015 because, according to that report, they were scheduled to expire that year. However, the Protecting Americans from Tax Hikes Act of 2015 extended these tax expenditures, and JCT provided estimates for FY 2016.

Note: These forgone revenue amounts are not solely for manufacturing. They are for all corporations or individuals that used the tax expenditures, including those in other sectors of the economy. Tax expenditures' revenue loss estimates do not necessarily represent the exact amount of revenue that would be gained if a specific tax expenditure was repealed because repeal of the tax expenditure could change taxpayer and economic behavior in some way that would affect revenue. The repeal could also affect economic activities related to other tax provisions or government programs, according to Treasury officials.

The overall effects of these nine tax expenditures across the manufacturing sector are difficult to quantify. DOC officials told us that tax expenditures are important, but they do not measure or analyze their effects. Treasury officials told us that these tax expenditures support manufacturing, but they do not measure or analyze their effects either. To understand the expenditures' effects, Treasury officials said they would have to identify which corporations are involved in manufacturing and how they used the tax expenditure. They also told us that many of the tax expenditures do not directly impact manufacturing activity, which also makes them difficult to measure. In a 2016 report, we found that federal agencies did not identify how a large proportion of tax expenditures contributed to agency goals, including the nine tax expenditures we selected that support manufacturing.[35] We also noted in that report that agencies may not assess the effectiveness of tax expenditures because of a reported lack of clarity about their roles and challenges with performance measurement. We found in 2013 that there is a lack of sufficient data available to estimate the degree to which some tax expenditures are used because tax forms do not collect specific data on them.[36] To help address these issues, we recommended that federal agencies identify which tax expenditures contribute to their goals. As of November 2016, this recommendation remained open.

Deferral of the Active Income of Controlled Foreign Corporations. This tax expenditure defers taxes for U.S.-based firms that own foreign subsidiaries. The Joint Committee on Taxation (JCT) estimated the forgone revenue for this expenditure to be $99.3 billion for fiscal year 2015. We previously reported that the federal government taxes the

[35]GAO, *Tax Expenditures: Opportunities Exist to Use Budgeting and Agency Performance Processes to Increase Oversight*, GAO-16-622 (Washington, D.C.: July 7, 2016).

[36]GAO, *Tax Expenditures: IRS Data Available for Evaluations Are Limited,* GAO-13-479 (Washington, D.C.: Apr. 30, 2013).

worldwide income of U.S. corporations, whether earned domestically or abroad, and that this tax expenditure allows firms to defer paying taxes on income earned by foreign subsidiaries until it is distributed to the U.S. parent corporation or other U.S. shareholders. Although the distribution and ultimate beneficiaries of this expenditure are unknown, there is some evidence that companies in the manufacturing sector may benefit more from deferral than others, according to our prior work.[37] An Internal Revenue Service (IRS) study found that during the one-time U.S. repatriation tax holiday, which allowed U.S. corporations to bring income back to the United States tax-free, in 2004, certain industries, such as companies involved in pharmaceutical manufacturing and computer and electronic equipment manufacturing, benefited disproportionately, as they repatriated significantly more income that year in the form of dividends relative to the size of the tax filers.[38]

Accelerated depreciation for certain capital assets, including bonus depreciation. This tax expenditure boosts the cash flow of firms because it allows them to consider assets as tax deductible expenses more quickly, thereby reducing the amount of income that is taxed. JCT estimated forgone revenue for this accelerated depreciation tax expenditure to be $90.6 billion for fiscal year 2016.

Deduction for qualified domestic production activities. This tax expenditure is a tax incentive for businesses to invest or expand their manufacturing in the United States. JCT estimated the forgone revenue for this tax expenditure to be $16.2 billion for fiscal year 2015. According to the JCT report, it was intended to lower the tax burden on domestic manufacturers as well as to attract new investments in domestic manufacturing facilities.[39] For this provision, taxpayers can deduct 9 percent of taxable income derived from eligible activities, according to the JCT report. The eligible activities relate primarily to manufacturers, but other types of firms may also qualify, according to CRS. Manufacturing accounted for an estimated two-thirds of the total value of claims for the domestic production activities deduction by taxpayers in 2009, according to a 2012 report from JCT.

[37]GAO, *Corporate Tax Expenditures: Evaluations of Tax Deferrals and Graduated Tax Rates*, GAO-13-789 (Washington, D.C.: Sept. 16, 2013).

[38]See IRS, *The One-Time Received Dividend Deduction,* SOI Bulletin (Spring 2008).

[39]Joint Committee on Taxation, *Background and Present Law Relating to Manufacturing Activities Within the United States,* JCX-61-12, (July 17, 2012).

Research and Experimentation (R&E) tax credit. This tax expenditure provides incentives for R&E. JCT estimated the forgone revenue for the R&E tax expenditure to be $8.3 billion for fiscal year 2016. The R&E tax credit can encourage business investment in research intended to foster innovation and promote long-term economic growth. This credit lowers the cost of qualified research, which can encourage more investment for that purpose. Manufacturing accounted for 64 percent of the value of claims for the credit by corporations in 2011, according to a report from the Committee on the Budget, U.S. Senate.[40]

Expensing of Research and Experimental Expenditures. This tax deduction also provides incentives for R&E. JCT estimated the forgone revenue for this deduction to be $4.8 billion for fiscal year 2015. The deduction gives corporations investing in R&D the option to recover a portion of the expenses they incur or pay in undertaking those investments. According to data published by the National Science Foundation, manufacturing firms performed or funded 68 percent of domestic R&D paid for by companies in all industries in 2013, suggesting that the manufacturing sector may be a significant beneficiary of this expenditure.

Option to claim a refundable accelerated Alternative Minimum Tax credit in lieu of bonus depreciation allowance. This tax expenditure enables firms who have an operating loss in the current year and have unused Alternative Minimum Tax credits to increase their cash flow by claiming the optional refundable credit instead of a bonus depreciation allowance that would only boost their net operating loss in the current tax year. JCT estimated forgone revenue for the option to claim a refundable accelerated Alternative Minimum Tax credit to be $2.5 billion for fiscal year 2016.

Last-in-first-out inventory accounting method. This method enables taxpayers to reduce the tax burden on the difference between the sales price and the cost of inventories and creates additional opportunities for firms to plan ahead and reduce the amount of taxes they pay. JCT

[40]Committee on the Budget, United States Senate, *Tax Expenditures: Compendium of Background Material on Individual Provisions,* Prepared by the Congressional Research Service, 91-950cc (Washington, D.C.: December 2014).

estimated forgone revenue for the last-in-first-out inventory accounting method to be $1.8 billion for fiscal year 2015.[41]

Inventory property sales source rule exception. This tax expenditure provides benefits to businesses when exporting their manufactured goods. JCT estimated the forgone revenue for this expenditure to be $1.7 billion for fiscal year 2015. According to a 2014 Congressional report, it exempts a portion of a firm's export income from U.S. taxation by using the tax code's rules governing the source of inventory sales and interacting with the tax code's foreign tax credit provisions.[42] As a result, this exception for inventory sales will raise the rate of return from investing in exporting. Because manufactured goods account for the majority of U.S. exports, manufacturers may be likely to receive notable benefits from this tax expenditure.

Partial exclusion on gains from the sale or exchange of qualified small business stock. This tax expenditure aims to help increase the flow of equity capital to smaller firms that are having difficulty raising capital from traditional sources (i.e. owner investment and banks). JCT estimated forgone revenue for the partial exclusion for small business stock to be $0.9 billion for fiscal year 2015.

[41]According to Treasury officials, the Treasury does not consider this accounting method to be a tax expenditure. We included it here because both the Congressional Research Service (CRS) and Joint Committee on Taxation (JCT) included it in their lists, and JCT provided an estimate of foregone revenue. While, in general, the tax expenditure lists that Treasury and JCT publish annually are similar, they differ somewhat in the number of tax expenditures reported and the estimated revenue loss for particular expenditures, for various reasons. See GAO, *Tax Expenditures: Background and Evaluation Criteria and Questions*, GAO-13-167SP (Washington, D.C.: Nov. 29, 2012).

[42]Committee on the Budget, 2014.

Programs Reported Addressing Manufacturing Trends in Different Ways, and Some Face Challenges in Doing So

Three Trends Are Occurring in a Rapidly Changing U.S. Manufacturing Sector

There are three general trends in the manufacturing sector: movement toward advanced manufacturing, need for workers with higher skills, and more globalization and competition for U.S. manufacturers, according to our analysis of selected reports and experts we interviewed.[43] The U.S. manufacturing sector is changing from a traditional manufacturing sector (i.e., one based on assembly lines and large numbers of employees) to an advanced manufacturing sector, according to PCAST. PCAST also reported that a highly skilled workforce will be critical to the deployment of an advanced manufacturing sector in the United States. At the same time, the manufacturing sector is becoming more globalized. PCAST reported that supporting advanced manufacturing innovation in the United States is critical to U.S. global competitiveness. U.S. manufacturers are increasingly competing with manufacturers in other countries as supply chains are becoming global and other countries are providing support for their manufacturing sector to make them more competitive, according to an expert we spoke to.

Most Programs We Identified Reported They Have Addressed Manufacturing Trends in Different Ways

Fifty-one of the 58 federal programs selected for our review are addressing one or more of the manufacturing trends in different ways, according to our survey of agency officials. Our analysis of survey responses shows that more than two thirds of programs are addressing the shift toward advanced manufacturing, approximately half of the programs are taking steps to address increased globalization and competition, and less than half are addressing the need for a higher skilled workforce. Table 8 shows how many programs reported addressing each of these trends. Programs reported addressing trends in

[43]For more information on how we selected the reports and experts we spoke to and identified the trends, see appendix I.

several ways, including providing funding and resources, sharing information, and promoting coordination.

Table 8: Number of Federal Programs That Reported Addressing Each of the Manufacturing Trends

	Advanced Manufacturing	Higher Skilled Workforce	Globalization and Competition
Number of programs that reported addressing each trend	42	24	31

Source: GAO analysis of survey data. | GAO-17-240

Note: There are three general trends in the manufacturing sector: movement toward advanced manufacturing, a need for workers with higher skills, and more globalization and competition for U.S. manufacturers, according to our analysis of selected reports and experts we interviewed. Of the 51 programs that reported addressing manufacturing trends, some reported addressing more than one.

Programs Reported Providing Funding and Resources

Programs have provided funding and resources to address trends in the manufacturing sector, according to agency officials surveyed. Funding and resources include providing grants for R&D or training programs, targeting research funding through public-private partnerships, or supporting the development and testing of training tools related to new manufacturing technologies. Providing funding and resources was used to address all three of our identified manufacturing trends, though it was most commonly used to address advanced manufacturing, based on our survey results, as shown in table 9.

Table 9: Number of Programs That Reported Providing Funding and Resources to Address Each Manufacturing Trend

Trend	Number of programs that reported providing funding and resources
Advanced Manufacturing	31
Globalization and Competition	20
Higher Skilled Workforce	18

Source: GAO analysis of survey data. | GAO-17-240

Note: Some programs reported providing funding and resources to address more than one trend.

Examples of programs that reported providing funding and resources, according to officials:

- The Manufacturing USA program was identified by multiple experts we spoke to as a prominent federal effort addressing the advanced manufacturing trend. Federal agencies funded nine innovation institutes through a public-private partnership model to support R&D projects and workforce development in advanced technologies such as additive manufacturing and digital manufacturing, among others.
- The Department of Defense's (DOD) Mentor2 program seeks to ensure that training remains relevant to workforce needs by funding training programs in digital manufacturing that can also be accessed by a wider cross-section of the DOD workforce.
- The Department of Energy's (DOE) Concentrating Solar Power and Photovoltaics programs fund research, development, and demonstration of innovation technologies that have largely moved overseas.[44] According to DOE officials, applicants to these programs must demonstrate a commitment to promoting domestic manufacturing to receive grant funding. More specifically, funding applicants must develop a U.S. manufacturing plan that commits to, among other things, investing in new or existing U.S. manufacturing facilities, keeping certain activities such as final assembly in the U.S., and supporting a specific number of manufacturing jobs in the United States, according to DOE officials.

Programs Reported Sharing Information

Programs reported sharing information to address trends in the manufacturing sector, including developing training materials and preparing industry sector reports, among other things. Programs are sharing information to address all three trends, with the largest number addressing advanced manufacturing, based on our survey results, as shown in table 10.

[44]According to officials at the Department of Energy (DOE), Photovoltaics is the direct conversion of sunlight into electricity by a semiconductor.

Table 10: Number of Programs That Reported Sharing Information to Address Each Manufacturing Trend

Trend	Number of programs that reported sharing information
Advanced Manufacturing	13
Globalization and Competition	9
Higher Skilled Workforce	4

Source: GAO analysis of survey data. | GAO-17-240

Note: Some programs reported sharing information to address more than one trend.

Examples of programs that reported sharing information, according to agency officials:

- Officials with the MEP program told us that they developed training materials on new technologies and created a community of practice to promote information sharing across the national network of MEP Centers.[45] MEP also collaborated with the NIST Engineering Lab to hold a regional workshop for clients to share information about advances in emerging advanced manufacturing technologies such as collaborative robotics.[46]
- As part of the IMCP program, officials told us that the Department of Commerce (DOC) has worked with the Departments of Education and Labor to build working groups to prepare panels and content for annual IMCP summits. These groups focused on addressing the workforce skills gap and identifying successful models for skill development, providing technical assistance, and sharing federal funding opportunities to help communities build a workforce with the skills that their employers need.
- Officials from the International Trade Administration's Manufacturing program told us that they developed the Top Markets Report series—a collection of sector-specific reports designed to help U.S. exporters compare markets across borders. The reports highlight future export

[45]The Hollings Manufacturing Extension Partnership (MEP) program has centers in all 50 states and Puerto Rico.

[46]Collaborative robotics involves integrating the use of robotic systems into manufacturing processes to operate in collaboration with humans and other machines.

opportunities for advanced manufacturing technologies such as in additive manufacturing and smart grid products.[47]

Programs Reported Promoting Coordination

Some agency officials reported that their programs promote coordination among stakeholders in the manufacturing community by convening representatives from industry and academia to address manufacturing issues, and reaching out to communities to stimulate manufacturing in a specific region, among other activities. Coordination was used to address all three manufacturing trends, based on our survey results, as shown in table 11.

Table 11: Number of Programs That Reported Promoting Coordination to Address Each Manufacturing Trend

Trend	Number of programs that reported promoting coordination
Advanced Manufacturing	8
Higher Skilled Workforce	7
Globalization and Competition	5

Source: GAO analysis of survey data. | GAO-17-240

Note: Some programs reported promoting coordination to address more than one trend.

Examples of programs that reported promoting coordination, according to agency officials:

- DOE's Clean Energy Manufacturing Initiative has convened stakeholders from industry, academia, and leadership from DOE national laboratories and DOE to discuss how public and private entities can partner to boost manufacturing competitiveness, train the advanced manufacturing workforce, and promote innovative energy technologies. It has also partnered with DOE's Clean Energy Manufacturing Analysis Center, which works with industry and academia to provide research and analyses of factors driving manufacturing strategy in the United States.

[47]The smart grid refers to a class of technology being used to modernize utility electricity delivery systems using computer-based remote control and automation. These technologies are being used in electricity networks, including power plants, wind farms, homes and businesses.

- DOL's H-1B Technical Skills Training Grant Program has implemented several cross-sector initiatives to promote a higher skilled workforce. For example, DOL has facilitated a partnership among its Employment and Training Administration, DOE, and Oklahoma State University, among others, to provide training in advanced manufacturing and design tools related to working in the oil and gas industry. The agency has also partnered with the Peralta Community College District's Laney College to create the Advanced Manufacturing Medical/Biosciences Pipeline for Economic Development, which promotes technology transfer, economic development, and workforce development in medical device and bioscience manufacturing.
- DOC's IMCP program has established collaboration among different public and private entities within identified communities to stimulate manufacturing and attract investment from global manufacturers. In particular, the program focuses on regions working across the public, private, and academic sectors to address issues related to workforce development, trade and international investment, and access to capital, among other things.

Some Programs Reported Facing Challenges in Addressing Trends in the Manufacturing Sector

According to our survey, 28 of the 51 programs that reported addressing manufacturing trends also reported facing challenges in addressing the changing manufacturing sector. Most of the challenges reported by these programs related to the trends we identified—advanced manufacturing, higher-skilled workforce, and globalization and competition—with some reporting multiple challenges related to a single trend. As shown in table 12, the most frequently-mentioned challenge for programs that are addressing the advanced manufacturing sector was a lack of resources and funding. For example, most of NSF's programs, which are primarily basic R&D programs, receive many more competitive proposals than can be funded by the available budget, according to NSF program officials. Challenges mentioned by other programs included a lack of information about advanced technologies, technical challenges, and difficulty in coordinating across agencies. We have identified technical challenges related to advanced manufacturing in our previous work on additive manufacturing.[48] For example, in 2015 we found there were limited materials available with which the technology could be used, and technical limitations on the speed of production and the ability to build

[48]GAO-15-505SP.

items of varying sizes. Experts in additive manufacturing told us that these challenges could be addressed through additional R&D.

Table 12: Types of Challenges Programs Reported Facing in Supporting Advanced Manufacturing

Advanced Manufacturing Challenges Reported	
Types of challenges	**Number of programs**
Lack of resources/funding	10
Lack of information	2
Technical challenges	1
Coordination challenges	1

Source: GAO analysis of survey data. | GAO-17-240

As the U.S. manufacturing sector becomes more oriented toward advanced manufacturing, the federal government faces challenges in helping workers develop the skills for the advanced manufacturing sector, according to some experts we interviewed. Program officials who told us that they are addressing the need for a higher skilled workforce said that they are primarily facing challenges in keeping training relevant to the current workforce (see table 13). For example, DOD's Mentor2 program officials reported encountering challenges ensuring not only that training for jobs in new manufacturing technologies is continually being updated, but also that it remains relevant as requirements change over time.

Table 13: Types of Challenges Programs Reported Facing in Building a Higher Skilled Workforce

Higher Skilled Workforce Challenges Reported	
Types of challenges	**Number of programs**
Keeping training relevant to current workforce	4
Coordination challenges	1

Source: GAO analysis of survey data. | GAO-17-240

Program officials told us their programs face a variety of challenges in an increasingly globalized and competitive manufacturing sector. As shown in table 14, programs addressing the increased globalization trend most frequently mentioned challenges related to promoting domestic production, while also pointing to limited resources and information, as well as issues with supply chain management. Among the programs, DOE's Photovoltaics and Tech-to-Market programs reported encountering challenges because manufacturing of key components has largely moved

overseas. Program officials said that the globalized nature of photovoltaic manufacturing makes it challenging to incentivize companies to produce them in the United States when the much larger scale of production for these panels overseas results in lower costs. However, as manufacturing costs further decline and shipping costs become a larger fraction of the total panel cost, there will be opportunities for onshoring of manufacturing and implementation of the U.S. manufacturing plan that promotes domestic production of renewable technologies, according to program officials.[49]

Table 14: Types of Challenges Programs Reported Facing Related to Increased Globalization and Competition

Globalization and Competition Challenges Reported	
Types of challenges	**Number of programs**
Promoting domestic production when facing challenging market conditions	6
Limited resources	2
Lack of information	1
Challenges in supply chain management	1

Source: GAO analysis of survey data. | GAO-17-240

[49]According to DOE officials, a U.S. manufacturing plan is required to be submitted by applicants for all research and development funding opportunities issued by DOE's Office of Energy Efficiency and Renewable Energy, which represents the applicant's measurable commitment to support U.S. manufacturing through the results of its award. A U.S. manufacturing plan must include specific and measurable commitments to U.S. manufacturing, according to program officials. For example, an applicant may commit particular types of products to be manufactured in the United States, may commit to a particular investment in a new or existing U.S. manufacturing facility, keep certain activities based in the United States, or support a certain number of jobs in the United States related to the technology and manufacturing.

Most Programs Reported Goals or Measures Related to Support of Manufacturing, and an Interagency Group Has Not Identified the Information It Needs to Report on Progress in Supporting Advanced Manufacturing

Most of the 58 programs reported having performance goals or measures related to the support of manufacturing. In addition, 4 programs had performance evaluations that specifically examined their effects on manufacturing. Apart from agency efforts to assess the performance of individual programs, a federal interagency initiative coordinates activities and assesses progress in the area of advanced manufacturing. However, agencies that comprise an interagency group have not identified the information needed to determine progress in meeting strategic plan objectives.

Most Programs Reported Having Performance Goals or Measures Related to Supporting Manufacturing

Forty-four of the 58 programs reported having at least one performance goal or measure related to the support of manufacturing. These goals and measures cover a range of areas, which reflects differences in each program's mission. Half of the 44 programs reported goals or measures related to advancing scientific knowledge or improving technologies. Fewer programs reported goals or measures in other areas, such as providing technical assistance to manufacturers, enhancing national security or medical countermeasures preparedness, promoting U.S. exports or open trade, or workforce development.[50]

- **Advancing scientific knowledge or improving technologies.** Twenty-two of the 44 programs reported at least one performance goal or measure related to supporting fundamental scientific research in areas such as nanomanufacturing and robotics. Such research has the potential to support manufacturing to the extent that it is subsequently applied to products or manufacturing processes. In addition, several programs reported performance goals or measures related to improving technologies, such as developing an energy-saving technology or alternative fuel to the point that it becomes cost-

[50]While most programs had goals or measures in just one area, such as advancing scientific knowledge, four programs had goals or measures in multiple areas.

competitive with existing technologies. Table 15 provides examples of reported performance goals and measures in this area.

Table 15: Examples of Reported Program Performance Goals or Measures Related to Advancing Scientific Knowledge or Improving Technologies

Program	Agency	Reported purpose/description	Reported performance goals or measures
Biotechnology and Biochemical Engineering Program	National Science Foundation (NSF)	To support innovative research and education in the fields of biopharmaceuticals, biotechnology, and bioenergy	• Support of fundamental engineering research that advances the understanding of cellular and biomolecular processes in engineering biology to enable technology for advanced manufacturing
Nanomanufacturing Program	NSF	To explore transformative approaches to nanomanufacturing, including but not limited to: micro-reactor and micro-fluidics enabled nanosynthesis, bio-inspired nanomanufacturing, and manufacturing by nanomachines	• Support fundamental research that ultimately leads to the manufacture of useful nano-scale materials, structures, devices, and systems
National Robotics Initiative	NSF	To accelerate the development and use of robots in the United States that work beside or cooperatively with people	• Support fundamental research that furthers knowledge in the area of robotics without specifically targeting an individual application
Concentrating Solar Power Program	Department of Energy	To provide competitive awards to industry, national laboratories, and universities with the goal of making large-scale solar energy systems cost competitive by the end of the decade	• Achieve a levelized cost of solar-generated electricity of 6 cents per kilowatt hour by the year 2020.

Source: GAO survey of agency officials | GAO-17-240

- **Providing technical assistance to manufacturers.** Four of the 44 programs reported at least one performance goal or measure related to providing technical assistance to manufacturers. These include goals and measures that quantify how assistance provided to manufacturing firms helped them. Table 16 provides examples of reported performance goals and measures in this area.

Table 16: Examples of Reported Program Performance Goals or Measures Related to Providing Technical Assistance to Manufacturers

Program	Agency	Reported purpose/description	Reported performance goals or measures
Hollings Manufacturing Extension Partnership (MEP)	Department of Commerce (DOC)	To provide U.S. manufacturers with access to technologies, resources, and industry experts through a federal-state-industry partnership	• Number of firms that receive in-depth technical assistance from MEP centers • Number of firms receiving services from MEP centers where those services were substantial and could be assumed to have led to positive impacts • Percentage of MEP clients receiving technical assistance that reported increasing sales, reducing costs, or making new investments in the services received
Trade Adjustment Assistance for Firms (TAAF)	DOC	To provide technical assistance to help U.S. firms experiencing a decline in sales and employment—resulting in part from the increase in imports of like or directly competitive articles—to become more competitive in the global marketplace	• The extent to which client firms increased their sales, employment levels, and productivity following the implementation of TAAF-supported projects to increase their global competitiveness

Source: GAO survey of agency officials. | GAO-17-240

- **Maintaining national security or medical countermeasures preparedness.** Six of the 44 programs reported performance goals or measures pertaining to the maintenance of production and manufacturing capabilities for national defense, or medical countermeasure preparedness for emerging infectious diseases and other threats. Table 17 provides examples of reported performance goals and measures in this area.

Table 17: Examples of Reported Program Performance Goals or Measures Related to National Security or Medical Countermeasures Preparedness

Program	Agency	Reported purpose/description	Reported performance goals or measures
Industrial Base Analysis and Sustainment Program	Department of Defense (DOD)	To maintain or improve the health of essential parts of the defense industry by avoiding reconstitution costs for capability after a Defense procurement hiatus; and to monitor and assess the industrial base, to address critical issues relating to urgent operational needs and industrial base vulnerabilities	• Address critical issues in the industrial base relating to urgent operational needs • Support the monitoring and assessment of the industrial base • Address supply chain vulnerabilities
Defense Production Act, Title III	DOD	To create assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense. Enables the government to apply financial incentives to encourage private industry to create new domestic sources of supply for key advanced materials and technology	• Respond to actions taken outside of the United States that could result in reduced supplies of strategic and critical materials necessary for national defense and the general economic well-being of the United States
Centers for Innovation in Advanced Development and Manufacturing	Department of Health and Human Services (HHS)	To provide advanced development and manufacturing capabilities for medical countermeasure development for emerging infectious diseases; chemical, biological, radiological, and nuclear threats; as well as the manufacturing of pandemic influenza vaccine.	• Establish public-private partnerships to construct or retrofit U.S.-based, commercial-scale, biopharmaceutical facilities that support advanced development and manufacturing of medical countermeasures • Provide, in an emergency, a U.S.-based surge capacity to respond to an emerging infectious disease, pandemic influenza, and currently known or unknown threats[a]

Source: GAO survey of agency officials. | GAO-17-240

[a]Besides having goals supporting medical countermeasures preparedness, the Centers for Innovation in Advanced Development and Manufacturing program has a workforce development goal to provide biopharmaceutical-oriented workforce development through training programs.

- **Promoting U.S. exports or open trade.** Six of the 44 programs reported performance goals or measures related to promoting U.S. exports or open trade. Such goals and measures include removing, reducing, and preventing trade barriers. Table 18 provides examples of reported performance goals and measures in this area.

Table 18: Examples of Reported Program Performance Goals or Measures Related to Promoting U.S. Exports or Open Trade

Program	Agency	Reported purpose/description	Reported performance goals or Measures)
Industry Trade Policy and Analysis	Department of Commerce (DOC)	To support U.S. government trade policy formulation and negotiations by providing the trade and economic analysis and issue expertise needed to expand exports and foreign direct investment in the United States	• Remove, reduce, and prevent trade barriers • Number of clients assisted
Manufacturing Program	DOC	To support exports and foreign direct investment in the United States by using industry expertise and an understanding of the dynamics of global competition to develop and implement policies and improve U.S. business competitiveness globally	• Number of clients served • Number of trade barriers removed
Trade Enforcement and Compliance Policy and Negotiations	DOC	To oversee policies and programs related to the negotiation of and pursuing foreign compliance with trade and investment disciplines in international agreements; the administration of U.S. antidumping and countervailing duty laws; the negotiation and administration of suspension agreements of U.S. antidumping and countervailing duty investigations	• Remove, reduce, and prevent trade barriers • Number of clients assisted

Source: GAO survey of agency officials | GAO-17-240

- **Developing the workforce.** Seven of the 44 programs reported performance goals or measures related to workforce development, such as developing occupational profiles and obtaining and retaining employment. Table 19 provides examples of reported performance goals and measures in this area.

Table 19: Examples of Reported Program Performance Goals or Measures Related to Developing the Workforce

Program	Agency	Reported purpose/description	Reported performance goals or measures
Registered Apprenticeship	Department of Labor (DOL)	To train workers through a network of 21,000 programs consisting of over 150,000 employers. Apprenticeships prepare a skilled workforce for expanding industries like health care, information technology, transportation, telecommunications, and advanced manufacturing, as well as in industries like construction where apprenticeships have a long history.	• Develop at least three national apprenticeship programs with new employers • Develop occupational profiles for targeted occupations identified in each of the sectors of excellence in apprenticeship
Trade Adjustment Assistance	DOL	To fund employment and training services to manufacturing and other eligible workers who lose their jobs as a result of the negative impacts of global trade.	• Entered employment rate: the percentage of participants who were employed in the first quarter after exiting the program • Employment retention rate: the percentage of participants who remain employed in the third quarter after exiting the program • Average earnings: the average earnings in the second and third quarters for participants after exiting the program

Source: GAO survey of agency officials. | GAO-17-240

- **Other areas.** Three of the 44 programs reported performance goals or measures in other areas, such as holding successful manufacturing-related events and tracking the amount of loans provided for manufacturing.

Four Programs Reported Having Evaluations That Examined Their Impact on Manufacturing

Of the 58 programs in our survey, 4 specifically estimated their effects on manufacturing with an independent performance evaluation that met our definition of a program evaluation.[51]

- **Trade Adjustment Assistance for Firms (TAAF, DOC)**—In 2012, we examined, among other things, the program's data and performance measures and what they indicated about the program's effectiveness.[52] The review found that although the program provides limited data about outcomes, manufacturing firms that have participated in the program have experienced small, positive, and statistically significant increases in sales.
- **Hollings Manufacturing Extension Partnership (MEP, DOC)**—There have been three evaluations of the program, all conducted by independent groups. Two of the evaluations, conducted in 2012 and 2015 by the Center for Economic Studies (CES) at the U.S. Census Bureau, examined how manufacturing establishments have been affected by MEP's assistance.[53] In 2013, the National Research Council conducted a meta-analysis of previous program evaluations of MEP going back to the early 1990s. Each of the three evaluations found that MEP had some positive effects, such as increased establishment productivity and productivity per worker.
- **Bioenergy Technologies Office (BETO, DOE)**—This program, which supports the manufacturing of bioproducts, has received biennial peer reviews that assess BETO's individual projects and the

[51]Program evaluations are systematic studies using objective measures and research methods to assess how well a program is working and why. Evaluations answer specific questions about program performance—either operations or results—and may apply to a program, project, activity, or policy. Evaluations may be conducted to provide accountability or to learn how to improve program performance. See *GAO*, *Performance Measurement and Evaluation: Definitions and Relationships*, GAO-11-646SP (Washington, D.C.: May 2011).

[52]GAO, *Trade Adjustment Assistance: Commerce Program Has Helped Manufacturing and Services Firms, but Measures, Data, and Funding Formula Could Improve*, GAO-12-930 (Washington, D.C.: September 2012).

[53]Center for Economic Studies, U.S. Census Bureau, Clifford A. Lipscomb, et al., "Evaluating the Long-Term Effect of NIST MEP Services on Establishment Performance," CES 15-09, (Washington, D.C.: March 2015); Jan Youtie, Board on Science, Technology, and Economic Policy, National Research Council, National Academy of Science, "21st Century Manufacturing: The Role of the Manufacturing Extension Partnership Program," Appendix B, *An Evaluation of the MEP: A Cross Study Analysis*, (Washington, D.C.: 2013). SRI International, Center for Economic Studies, U.S. Census Bureau, Christopher Ordowich, et al., "Evaluating the Impact of MEP Services on Establishment Performance: A Preliminary Empirical Investigation," CES 12-15, (Washington D.C.: July 2012).

overall management, performance, and strategic direction of the Office. In 2013 and 2015 peer reviews, external reviewers delivered a positive overall assessment of BETO and validated much of the office's current approach and technical strategy. The reviews noted that BETO is funding high-impact projects that have the potential to significantly advance the state of technology for the industry and made recommendations for further improvement.[54]

- **Manufacturing Machines and Equipment (MME, NSF)**—The program was evaluated in 2013 by the independent Science and Technology Research Institute.[55] The study concluded that, among other things, the NSF, through the MME program, has positively "contributed to the emergence of additive manufacturing over the last 25 years."

An Interagency Subcommittee Coordinates Agencies' Advanced Manufacturing Efforts but Has Not Identified the Information Needed to Report Progress toward Achieving Strategic Objectives

Apart from these efforts to assess the performance of individual programs, there is an interagency subcommittee—the Subcommittee on Advanced Manufacturing (SAM)—which was tasked by the NSTC's Committee on Technology with, among other things, coordinating federal agencies' activities and reporting on the federal government's progress in a particular area—advanced manufacturing. SAM is co-chaired by OSTP. Ten of the 11 agencies that administer programs in this review are represented on the SAM and, as we discussed earlier regarding agencies' actions to address manufacturing trends, 42 of the 58 programs in this review reported addressing advanced manufacturing. SAM provides support for implementation of the National Strategic Plan for Advanced Manufacturing, a plan developed in 2012 in response to the America COMPETES Reauthorization Act of 2010. The strategic plan included five objectives (see sidebar). The strategic plan also included suggested indicators or metrics for tracking progress over the short-term and long-term and identified the federal agencies that should implement actions to achieve them.

[54]U.S. Department of Energy, Energy Efficiency and Renewable Energy, Biotechnology Energies Office, 2013 Peer Review Report: Review Panel Summary Report and Project Results, DOE/EE-1014, (February 2014) and 2015 Peer Review Report: Review Panel Summary Report and Project Results, DOE/EE-1386, (March 2016). According to DOE officials, the Advanced Manufacturing Office also conducts peer reviews that are similar to those done at the Bioenergy Technologies Office. We did not review these evaluations.

[55]Science & Technology Policy Institute, Christopher L. Weber et al., "The Role of the National Science Foundation in the Origin and Evolution of Additive Manufacturing in the United States", IDA Paper P-5091, (November 2013).

Objectives of the National Strategic Plan for Advanced Manufacturing

1. Accelerate investment in advanced manufacturing technology, especially by small and medium-sized manufacturing enterprises, by fostering more effective use of federal capabilities and facilities, including early procurement by federal agencies of cutting-edge products.
2. Expand the number of workers who have the skills needed by a growing advanced manufacturing sector and make the education and training system more responsive to the demand for skills.
3. Create and support national and regional public-private, government-industry-academic partnerships to accelerate investment in and deployment of advanced manufacturing technologies.
4. Optimize the federal government's advanced manufacturing investment by taking a portfolio perspective across agencies and adjusting accordingly.
5. Increase total U.S. public and private investments in advanced manufacturing R&D.

Source: A National Strategic Plan for Advanced Manufacturing, Executive Office of the President, National Science and Technology Council, February 2012. I GAO-17-240

Federal agencies identified in the strategic plan are to implement actions to achieve one or more of the plan's objectives. For example, the fourth objective of the plan is to optimize the federal government's advanced manufacturing investment by taking a portfolio perspective across agencies and adjusting accordingly. To achieve this objective, the plan lists actions that agencies can take, including: (1) coordinating federal agency investments in the knowledge and capabilities shared across the manufacturing sector and (2) targeting and balancing investments in advanced materials, broad production technology platforms, advanced manufacturing processes, and design and data infrastructure. The strategic plan then identifies the Departments of Commerce, Defense, Energy, and the National Science Foundation as the agencies responsible for implementing these actions. The plan notes that the federal government has current investments in advanced manufacturing R&D as well as plants and equipment that help to position promising technologies for broad adoption and commercialization or to meet certain essential national security needs. By coordinating the federal government's portfolio of these investments, the plan envisions that these investments will increase the global competitiveness of U.S. manufacturing and help to create a fertile domestic environment for innovation.

The strategic plan identifies potential measures that could be used to measure progress toward these objectives but does not specify what information should be submitted by agencies. For example, the plan identifies short-term measures for achieving objective four: (1) development and implementation of a framework for managing the whole-of-government portfolio, and (2) number and scale of multi-agency advanced manufacturing funding solicitations. Long-term measures include: (1) balance of federal advanced manufacturing R&D investment across portfolio dimensions, including basic research, applied research, demonstration facilities, and others and (2) accelerated time-to-market of new advanced manufacturing processes and products. While the plan identifies these short and long-term metrics, it does not include reporting requirements for agencies on these metrics to measure their progress toward the objective.

The RAMI Act requires NSTC's Committee on Technology to periodically update the strategic plan for advanced manufacturing and to describe the progress made in achieving the objectives from prior strategic plans, including a discussion of why specific objectives were not met. Under its charter, one of the SAM's purposes is to provide support for implementation of and updates to the strategic plan for advanced

manufacturing. As required by the RAMI Act, the SAM plans to update the strategic plan on May 1, 2018, including reporting on the progress made in achieving the objectives from prior strategic plans. However, it has not identified the information it will collect from federal agencies to determine the extent to which the strategic plan objectives are being achieved.

One of the key practices for enhancing and sustaining interagency collaborative efforts is developing mechanisms to monitor, evaluate, and report results. As we previously reported, federal agencies engaged in collaborative efforts need to create the means to monitor and evaluate their efforts to enable them to identify areas for improvement.[56] As a part of this effort, agencies should consider whether there is a way to track and monitor progress toward the short and long-term outcomes.[57]

According to SAM officials, the information to be collected to evaluate progress in achieving the objectives of the strategic plan has not yet been determined. The SAM's role, according to its charter, is to serve as a forum for information sharing, collaboration, and consensus-building among agencies regarding federal policy, programs, and budget guidance for advanced manufacturing. The SAM generally holds two to three meetings per year with between 30 and 50 officials across 13 different agencies, where officials have conversations about their programs and investments, and the SAM helps to put these efforts into a broader context, according to SAM officials. While these discussions include leading practices regarding measuring program effectiveness, according to SAM officials, the SAM's role is not to provide top-down direction to agencies regarding how to measure effectiveness.[58] While the SAM's role under its charter includes collaboration and consensus-building among agencies, OSTP, as a co-chair of the subcommittee, has not worked with SAM member agencies to specify the information needed to report progress in meeting strategic plan objectives, which is inconsistent with a key practice for interagency collaboration. Without specifying the information it will collect from federal agencies, SAM may lack consistent, comprehensive information that would help it fully report on the progress

[56]GAO, *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: October 2005).

[57]GAO, *Managing For Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, GAO-12-1022 (Washington, D.C.: September 2012).

[58]The SAM was involved in helping developing metrics for the manufacturing institutes under the Manufacturing USA program, according to SAM officials.

in achieving the objectives of the National Strategic Plan for Advanced Manufacturing.

Conclusions

The health of the U.S. manufacturing sector has long been a concern, and the vast majority of the 58 programs we identified that support manufacturing reported taking steps to address trends in the sector, most prominently the movement toward advanced manufacturing. Federal law requires a government-wide strategic plan for advanced manufacturing to improve government coordination and provide long term guidance in support of manufacturing competitiveness. The next update of the strategic plan, which is required by 2018, must describe the progress made in achieving the objectives of the plan and include a discussion of why specific objectives were not met. SAM has worked to facilitate federal agency collaboration on advanced manufacturing and plans to report in 2018 on progress in achieving the strategic objectives. However, OSTP has not worked with SAM member agencies to identify the information it will collect from federal agencies to determine the extent to which the strategic objectives are being achieved. Consistent with a key practice for interagency collaboration, identifying the information needed from federal agencies would better position the federal government to report consistent, comprehensive information on the progress in achieving the objectives of the National Strategic Plan for Advanced Manufacturing.

Recommendation for Executive Action

To enhance the ability of the Executive Office of the President to implement RAMI Act requirements related to reporting on advanced manufacturing, we recommend that the Director of the Office of Science and Technology Policy, working through the National Science and Technology Council and agency leadership, as appropriate, identify the information they will collect from federal agencies to determine the extent to which the objectives outlined in the National Strategic Plan for Advanced Manufacturing are being achieved.

Agency Comments and Our Evaluation

We provided a draft of this report to USDA, DOC, DOD, DOE, DOL, Education, EPA, the Export-Import Bank, HHS, NSF, OSTP, SBA, and the Treasury for review and comment. We received the following comments:

- USDA did not provide any comments.

- DOC provided technical comments, which we incorporated as appropriate.
- DOD's GAO Liaison stated via e-mail that it concurred and had no comments on the report.
- DOE, DOL, and Education provided technical comments, which we incorporated as appropriate.
- EPA stated that it had no comments on the report.
- The Export-Import Bank, HHS, and NSF provided technical comments, which we incorporated as appropriate.
- OSTP's General Counsel provided comments via e-mail, which we discuss below.
- SBA provided technical comments, which we incorporated as appropriate.
- The Treasury stated that it had no comments on the report.

OSTP did not state whether it agreed or disagreed with the recommendation in our draft report but raised an issue related to the recommendation and suggested several revisions to its wording. Our draft report had recommended that OSTP, working through relevant agencies, develop a mechanism to collect information from federal agencies needed to determine the extent to which the objectives in the National Strategic Plan for Advanced Manufacturing are being achieved. OSTP stated that there is such a mechanism. According to OSTP, NSTC's subcommittees coordinate and agree on how to measure progress toward strategic plan goals and establish mechanisms to monitor, evaluate, and report results. OSTP cited the SAM's charter, which specifies that a function of the SAM is to provide periodic updates on the implementation of the strategic plan, among other things, to the Committee on Technology and the Assistant to the President for Science and Technology.

While we agree that the SAM charter provides for periodic updates on the implementation of the strategic plan, the focus of the draft recommendation was on the need to identify the specific information to be collected from federal agencies to report on progress made in achieving the objectives of the 2012 strategic plan. Without identifying such

information, the federal government may not be prepared to report consistent and comprehensive information on progress in meeting strategic plan goals. In response to OSTP's comments, we modified the report and the wording of our recommendation to be more precise by deleting the reference to developing a "mechanism" for collecting information and focusing on the need to identify the information to be collected.

OSTP also suggested several revisions to the wording of the recommendation, which we are not making for the following reasons:

- OSTP suggested directing the recommendation to the Assistant to the President for Science and Technology rather than the Director of the Office of Science and Technology Policy. We directed the recommendation to the Director of the Office of Science and Technology Policy because that is the office responsible under federal law for establishing the Committee on Technology, which is required to update the strategic plan.

- OSTP also suggested revising the recommendation to specifically mention the SAM. We did not specifically mention the SAM because its charter expired March 1, 2017, and the legal requirement to update the strategic plan is the responsibility of the Committee on Technology, established by the Director of OSTP. Also, while OSTP's General Counsel indicated that, as of March 2017, an extension to the charter was being considered, it was not clear whether any extension would include the period of time in which the update to the strategic plan is required to be completed under the RAMI Act.

- OSTP also suggested revising the recommendation to focus on the extent to which the objectives of the Advanced Manufacturing Partnership (AMP) recommendations are being achieved in periodic updates to the implementation of the National Strategic Plan for Advanced Manufacturing. The AMP recommendations are sets of recommendations proposed in a series of reports by PCAST. These recommendations were not all covered in the scope of our report. Instead, the focus of our recommendation was on reporting on the progress in achieving the objectives of the strategic plan, as required by the RAMI Act.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the

report date. At that time, we will send copies to the appropriate congressional committees; the Director of the Office of Science and Technology Policy; the Secretaries of Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Labor, and the Treasury; the Director of the National Science Foundation; the Administrators of the Environmental Protection Agency and the Small Business Administration; the Acting Chairman of the U.S. Export-Import Bank; and other interested parties. In addition, the report will be available at no charge on the GAO web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact Andrew Sherrill at (202) 512-7215 or sherrilla@gao.gov or John Neumann at (202) 512-3841 or neumannj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs are on the last page of this report. GAO staff who made major contributions to this report are listed in appendix III.

Andrew Sherrill
Director, Education, Workforce
and Income Security

John Neumann
Director, Natural Resources,
and Environment

List of Requesters

The Honorable Christopher A. Coons
Ranking Member, Subcommittee on Financial Services and General Government
Committee on Appropriations
United States Senate

The Honorable Roy Blunt
United States Senate

The Honorable Lindsey O. Graham
United States Senate

The Honorable Brian Schatz
United States Senate

The Honorable Mark R. Warner
United States Senate

Appendix I: Objectives, Scope, and Methodology

Our objectives were to examine (1) how selected federal programs provide support to U.S. manufacturing; (2) how selected federal tax expenditures provide support to U.S. manufacturing; (3) how, if at all, selected federal programs address manufacturing trends and what, if any, challenges they face; and (4) the extent to which federal agencies measure performance and assess effectiveness in supporting manufacturing generally, and advanced manufacturing specifically.

Identifying Federal Agencies

To address these objectives, we first identified federal agencies (i.e. any federal organization) that administered programs that support the manufacturing sector. We defined "support the manufacturing sector" broadly, including support for U.S. and foreign manufacturers that manufacture in the United States; programs that support U.S. manufacturers who manufacture or export their goods overseas, and programs that train workers who lose their jobs in manufacturing, whether they are being trained for other jobs in manufacturing or in another sector of the economy. To identify these agencies, we reviewed prior GAO and Congressional Research Service (CRS) reports, the President's 2016 budget, and the Catalog of Federal Domestic Assistance (CFDA). We identified 11 agencies that administered programs that support the manufacturing sector. We initially met with officials with the Departments of Commerce, Defense, and Energy. In our meetings with these three agencies, and in our interviews with experts at CRS and the Information Technology and Innovation Foundation, we asked officials if these 11 agencies were the main agencies that administer programs to support U.S. manufacturing, and if there were any other agencies that did so. After considering their input, we added 4 more agencies, bringing the total to 15 agencies that we contacted: The Departments of Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Housing and Urban Development, Labor, Transportation, and the Treasury; the National Aeronautics and Space Administration; the National Science Foundation; the Environmental Protection Agency; the Export-Import Bank; and the Small Business Administration.[1] After contacting Department of Housing and Urban Development officials, we

[1] We identified an additional five agencies that administered programs that support businesses in general, which may include support for manufacturing to some degree, but we did not collect additional information from them because of the low likelihood that their programs would have an identifiable focus on manufacturing. These agencies were the Departments of Homeland Security, the Interior, and Veterans Affairs; the Appalachian Regional Commission; and the National Technology Transfer Center.

eliminated the agency from consideration because the officials informed us that the sole manufacturing program that the team had identified no longer existed.

Identifying Programs

We then developed a list of programs administered by the 14 agencies on our list that appeared to directly target or indirectly support U.S. manufacturing. To identify programs, we searched prior GAO and CRS reports and program inventories developed by agencies, CFDA, www.manufacturing.gov, as well as agency web sites. We conducted keyword searches using words such as "manufacturing" and "manufacturers" to compile the initial list of programs. We then contacted each of the 14 agencies with an initial list of potential programs administered by their agency. We asked the officials if any programs administered by their agency should be added or removed from the list. We reviewed the agencies' input and determined whether the programs should be included in this review. To be selected as a program that supports manufacturing, the program had to meet the following criteria: (1) have an identifiable focus on manufacturing,[2] (2) be operational in fiscal year 2014 and at the time of selection in 2015, and (3) not be part of a larger program that was selected.[3] We then confirmed with each of the agencies the programs identified for their agency. Based on the agencies' input and our application of the criteria, we identified 58 programs administered by 11 agencies that met the criteria.

Identifying Tax Expenditures

To identify tax expenditures, we reviewed a 2013 CRS report titled "Federal Tax Benefits for Manufacturing: Current Law, Legislation in the 113th Congress, and Arguments For and Against Federal Assistance"

[2]We determined that a program had an identifiable focus on manufacturing if one or more of the following criteria were met: the program was called a manufacturing program in the program title; the program's description, objectives, or eligibility criteria included that it specifically supports manufacturing; agency officials stated that they could identify the number of participants or beneficiaries that are in manufacturing (e.g., manufacturing firms or workers trained in manufacturing); that they could identify the amount of the program's budget that benefits manufacturing; that the program's goals, performance measures, or performance metrics include a specific focus on manufacturing; or that the program has had a program evaluation conducted that focused on its effect on the manufacturing sector.

[3]For example, each of the military branches has their own Manufacturing Technology Program; however, for this report, we counted only the program that oversees each of those programs and is administered by the Department of Defense's Office of Manufacturing and Industrial Base Policy.

and spoke with experts from CRS and officials from the Department of the Treasury (Treasury). We asked Treasury officials if any tax expenditures should be added or removed from the list. The team then reviewed the agencies' input and determined whether the tax expenditure should be included in this review. To be selected as a tax expenditure that supports manufacturing, it had to meet the following criteria: (1) have a benefit for manufacturing, and (2) be operational in fiscal year 2014 and at the time of selection in 2015. Based on the agency's input and internal discussions, we selected nine tax expenditures that met the criteria. We then reviewed reports from the Joint Committee on Taxation (JCT) to obtain estimates of federal revenue forgone for each of the tax expenditures.[4] We reviewed, but did not verify, the procedures reported by JCT to estimate the magnitude of revenues forgone through tax expenditures.

Program Survey

We administered a web-based survey to agency officials for these programs to collect, among other data, descriptive information, budget and participation data, and information on efforts to address trends in manufacturing. To minimize errors arising from differences in how questions might be interpreted and to reduce variability in responses that should be qualitatively the same, we conducted pretests with six programs at six agencies, and we revised the survey based on pretest feedback. We conducted an additional pretest with two of the programs to ensure that revised questions used in the survey were understandable.

In February 2016, we notified agency officials that the survey was available online. We also made telephone calls to officials and sent them reminder messages, as necessary, to ensure their survey response. We analyzed and grouped the data we collected to describe the 58 programs and provide information on their size and scope. We did not conduct a legal analysis to confirm the various descriptions of the programs in this report, including information on their budgetary obligations, program goals, or intent. Further, we did not review or analyze agencies' financial data or materials prepared by the agencies in connection with the annual budget and appropriations process in developing this report. We used standard descriptive statistics to analyze responses to the survey.

[4]Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2015-2019,* JCX-141R-15, (Dec. 7, 2015) and *Estimated Budget Effects of Division Q of Amendment #2 to the Senate Amendment to H.R. 2029 (Rules Committee Print 114-40), the "Protecting Americans from Tax Hikes Act of 2015,"* JCX-143-15, (Dec. 16, 2015).

Because this was not a sample survey, there are no sampling errors. To minimize other types of errors, commonly referred to as nonsampling errors, and to enhance data quality, we employed recognized survey design practices in the development of the survey and in the collection, processing, and analysis of the survey data. On the basis of our application of recognized survey design practices and follow-up procedures, we determined that the data were of sufficient quality for our purposes.

For the obligations data we used in this report, our survey asked program officials to provide their program's total obligations (federal amount only) for fiscal years 2014, 2015, and 2016. The survey also asked programs to estimate the proportion of obligations the program used to support U.S. manufacturing, and it also asked for an explanation of how the proportions were determined. To assess the reliability of these data, we took the following steps. First, the survey question on the proportion of obligations that support U.S. manufacturing allowed programs to provide ranges or other approximate percentages if they did not know the precise numbers. Second, because we asked the programs to explain how they determined the proportion of obligations that supported U.S. manufacturing, we were able to understand, in a limited way, the reliability and validity of the proportions provided. In general, the programs that provided numbers and proportions also provided explanations that suggested the numbers were broadly reliable and accurate. Third, we checked the obligations data for a number of programs against publicly available budget data. The funding amounts provided by programs in our survey generally corresponded well. Fourth, we performed common data testing steps to assess the reliability of the data, including identifying outliers and missing data. Fifth, our questions requesting obligations funding were framed in terms of the programs' overall funding and budgets, rather than asking specifically for the amounts related to manufacturing. This made it more possible for programs to provide accurate numbers based on existing data sources.

We used these data to provide a broad understanding of funding levels across the population of 58 programs in this report. More specifically we report these numbers in two primary ways. First, in appendix II, we provide total obligations and the proportion going to manufacturing for all programs reporting these numbers. Second, in tables 2 through 6, we provided counts of the numbers of programs and aggregated obligation

totals for each agency in categories of programs.[5] We aggregated by summing the totals reported for these programs and categories by agency. We reported non-rounded obligations for programs mentioned in the text of the report, and we rounded numbers in the tables and in appendix II. Based on the data reliability steps described above, we determined that these data were sufficiently reliable for the purposes of this report.

Site Visits

To observe and obtain information on how selected programs support manufacturing, we conducted site visits to two locations: Chicago, IL and Knoxville, TN in October and November 2015. We selected these locations based on the following criteria: Each was a city where: (1) a Manufacturing USA institute was currently operating, (2) an Investing in Manufacturing Communities Partnership (IMCP) community was designated, and (3) a Hollings Manufacturing Extension Partnership (MEP) Center was currently operating. For variety in administering agencies, we determined that one city we selected had to have a Manufacturing USA institute that was overseen by the Department of Defense (DOD), and the other had to have an institute that was overseen by the Department of Energy (DOE). To obtain information across multiple policy areas, the IMCP had to have a workforce training and international trade component of their program to meet our criteria. At the time of our selection, there were six currently operating manufacturing institutes each overseen by either DOD or DOE.[6] During each site visit, we visited and toured the institute, interviewed IMCP and MEP officials, visited two manufacturers, and toured their facilities. For additional information on programs that train workers in manufacturing, we interviewed officials with two other organizations in Chicago, and we

[5]Table 2 provides aggregate totals by agency for all 58 programs in our review. These same programs are then represented in tables 3 through 6 by category of program.

[6]The six institutes were the Department of Defense's (DOD) National Additive Manufacturing Innovation Institute (America Makes) in Youngstown, OH; DOD's Digital Manufacturing and Design Innovation Institute in Chicago, IL; DOE's Institute for Advanced Composites Manufacturing Innovation in Knoxville, TN; DOD's Lightweight Innovations for Tomorrow in Detroit, MI; DOE's The Next Generation Power Electronics Manufacturing Innovation Institute (PowerAmerica) in Raleigh, NC; and DOD's American Institute for Manufacturing Integrated Photonics in Albany, NY. Since the time of our selection, three new manufacturing institutes have been established: DOD's America's Flexible Hybrid Electronics Manufacturing Institute (NextFlex) in San Jose, CA, DOD's Advanced Functional Fabrics of America in Cambridge, MA, and DOE's Clean Energy Smart Manufacturing Innovation Institute in Los Angeles, CA.

toured training facilities for one of them: the Jane Addams Resource Corporation (see table 20). The information we obtained on our site visits was not generalizable to all locations where these programs operated.

Table 20: Organizations and Agencies We Visited

	Chicago, IL	Knoxville, TN
Manufacturing USA institute	• Digital Manufacturing and Design Innovation Institute	• Institute of Advanced Composites Manufacturing Innovation
Investing in Manufacturing Communities Partnership community	• Chicago Metro Metal Consortium	• Drive! for the Future
Hollings Manufacturing Extension Partnership program	• Illinois Manufacturing Excellence Center	• Center for Industrial Services, University of Tennessee Institute for Public Service
Manufacturers	• Maxant Technologies • Ex-Cell Kaiser	• Windrock • Team Technologies
Export Assistance Centers	• Department of Commerce, International Trade Administration • Small Business Administration • Export-Import Bank	• Department of Commerce, International Trade Administration
Other organizations	• Cook County Workforce Partnership • Jane Addams Resource Corporation	

Source: GAO | GAO-17-240

Identifying Manufacturing Trends

We identified manufacturing trends by reviewing reports addressing manufacturing policy in the United States produced by the White House's Office of Science and Technology Policy (OSTP) and interviewing experts in the manufacturing sector. The reports were produced by the President's Council of Advisors on Science and Technology (PCAST) and National Science and Technology Council (NSTC) and written by experts in industry, academia, and government agencies tasked with helping the Executive Branch develop manufacturing policy in the United States. Specifically, PCAST and NSTC address the future of federal science and technology investments and make recommendations to improve policy in science, technology, and innovation. As table 21 shows, all of the reports we reviewed identified the advanced manufacturing capabilities and higher skilled jobs trends, while four of the five reports mentioned the increasingly complex and globalized nature of manufacturing. We interviewed seven experts in the manufacturing sector, and they agreed that these were three manufacturing trends. To select these experts, we selected an initial group of experts after we attended the Manufacturing

and Innovation: Making Value for America webinar on January 19, 2016. The webinar enabled us to identify three experts from the National Academy of Engineering (NAE) with specific knowledge regarding manufacturing trends. After speaking to the NAE experts, we asked if there were other experts in the sector that we should speak to. This afforded us the opportunity to identify additional experts from the private sector, non-profit organizations, and agency officials from the Department of Commerce and the National Science Foundation. The views of these experts cannot be generalized, but they provided additional perspectives.

Table 21: Analysis of Selected President's Council of Advisors on Science and Technology (PCAST) and National Science and Technology Council (NSTC) Reports to Identify Manufacturing Trends

Report title	Advanced manufacturing capabilities	Higher skilled jobs	Increasingly complex and globalized nature of manufacturing
"Accelerating U.S. Advanced Manufacturing", October 2014	yes	yes	no
"National Network for Manufacturing Innovation: A Preliminary Design", January 2013	yes	yes	yes
"Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing", July 2012	yes	yes	yes
"A National Strategic Plan for Advanced Manufacturing", February 2012	yes	yes	yes
"Report to the President on Ensuring American Leadership in Advanced Manufacturing", June 2011	yes	yes	yes
Total	**5**	**5**	**4**

Source: GAO analysis of PCAST and NSTC reports. | GAO 17-240

To determine the extent to which programs are addressing manufacturing trends, we included survey questions asking which trends programs are addressing, steps they have taken to address them within the past 3 years, and challenges they face in doing so. To analyze programs' survey responses, we categorized program responses based on what trends they were addressing, which allowed us to identify how many programs are taking steps to address each trend. We further categorized program

responses by analyzing steps programs are taking to address each trend and organized all program responses into three broad strategies: (1) providing funding and resources, (2) sharing information, and (3) promoting coordination. To determine challenges programs face in addressing manufacturing trends, we analyzed program responses to our survey questions related to challenges and determined how many programs reported challenges related to each of the trends. To further categorize the types of challenges programs face, we organized all program responses into three broad challenge categories: (1) lack of funding and resources, (2) lack of information, and (3) coordination challenges. To ensure the consistency and accuracy of this analysis, one analyst conducted the primary categorization and a second analyst reviewed that categorization and raised questions about particular results. The two analysts then discussed and resolved the questions. Additionally, a GAO social science methodologist with expertise in qualitative data analysis reviewed the underlying documentation for the analysis as a broad check on its accuracy and consistency.

Performance and Effectiveness

To examine the extent to which federal agencies measure the performance and assess the effectiveness in support of manufacturing generally and advanced manufacturing specifically, we asked agencies in our survey what manufacturing-related performance goals and metrics they used and what program evaluations had been conducted or planned in the past 5 years to assess any impact that the program had on the U.S. manufacturing sector. To analyze the evaluations identified by program officials, we obtained copies of the evaluations and reviewed them to see if they met GAO's definition of a program evaluation and whether they specifically evaluated the program's effect on manufacturing.[7] To analyze federal efforts to assess the effectiveness of support for advanced manufacturing specifically, we reviewed relevant federal legislation and prior GAO reports on interagency collaboration. We also interviewed officials with OSTP's Subcommittee on Advanced Manufacturing about their efforts to coordinate advanced manufacturing efforts across the federal government and evaluate progress in implementing the National Strategic Plan for Advanced Manufacturing.

[7] *GAO, Performance Measurement and Evaluation: Definitions and Relationships*, GAO-11-646SP (Washington, D.C.: May 2011).

Appendix II: Additional Information Reported by Programs We Identified That Support U.S. Manufacturing

This appendix provides information about the 58 programs that support U.S. manufacturing selected for our review. All of the information about budgetary obligations, descriptions, and activities (including any statements about the program goals or intent) is based on information provided by agency officials. In some cases, agency officials may have estimated or rounded their program's obligations for our survey. See appendix I for more information about our survey.

We did not conduct an independent analysis of this information. Further, we did not review agencies' financial data or materials prepared by the agencies in connection with the annual budget and appropriations process in developing this report. The programs are organized by the federal agency that administers them, listed alphabetically.

Bioenergy Program for Advanced Biofuels

Department of Agriculture, Rural Business-Cooperative Service

Funding for the Bioenergy Program for Advanced Biofuels

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$54	100%
Fiscal Year 2015	$14	100%
Fiscal Year 2016	Not reported	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2008

Program category: General financing

Program description: The Bioenergy Program for Advanced Biofuels supports expanded production of advanced biofuels by awarding payments to eligible advanced biofuel producers, thereby promoting sustainable economic development in rural America. Awards are based on producers' requests and the amount of biofuel they produce. Examples of awardees include producers of biodiesel from canola oil, greases, and soybean oil; ethanol from milo or sorghum; electricity from an on-farm anaerobic digester that uses animal waste as the feedstock; and manufacturing facilities that produce wood pellets.

Program activities that support manufacturing:

Payments: The program awards payments to manufacturing facilities that produce advanced biofuels.

Manufacturing Trends Addressed by the Program
The Bioenergy Program for Advanced Biofuels did not report it addressed GAO's identified manufacturing trends (advanced manufacturing, move to a higher skilled workforce, and increased globalization and competition).

Business and Industry Guaranteed Loan Program

Department of Agriculture, Rural Business-Cooperative Service

Funding for the Business and Industry Guaranteed Loan Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$1,084	23%
Fiscal Year 2015	$1,044	25%
Fiscal Year 2016	Not reported	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey
Year program created: 1972

Program category: General financing

Program description: The Business and Industry Guaranteed Loan Program seeks to improve the economic health of rural communities by bolstering the existing private credit structure by guaranteeing loans for rural businesses, which enables private lenders to provide more affordable financing for businesses in eligible rural areas. Examples include loans for purchasing and developing land; purchasing equipment, machinery, or other supplies; and business repair, modernization, or development.

Program activities that support manufacturing:
Loans: The program issues Loan Note Guarantees to private lenders enabling rural businesses, including manufacturers, to obtain loans. The loans provide better rates and terms to the businesses that receive them.

Manufacturing Trends Addressed by the Program
The Business and Industry Guaranteed Loan Program did not report it addressed GAO's identified manufacturing trends (advanced

manufacturing, move to a higher skilled workforce, and increased globalization and competition). The Business and Industry Guaranteed Loan Program provides loans but this role does not directly relate to manufacturing trends, and the program's mission is much broader than just manufacturing.

Advocacy Center

Department of Commerce, International Trade Administration, Global Markets

Funding for the Advocacy Center Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$3	60-80%
Fiscal Year 2015	$3	60-80%
Fiscal Year 2016	$4	60-80%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1993

Program category: Trade, Export promotion

Program description: The Advocacy Center serves as the primary interagency coordinator across 14 different agencies to execute "whole of government" approach to help U.S. exporters win business overseas. According to program officials, the center coordinates federal resources to assist U.S. businesses as they compete against foreign firms for specific foreign government contracts. The Center helps support and retain U.S. jobs through promoting U.S. exports and is essential in the success of initiatives from the International Trade Administration's (ITA) Global Market unit. Global Markets overseas staff counsel companies on advocacy, perform and coordinate advocacy efforts overseas, and provide key market intelligence that helps determine national interest and advocacy campaigns. Global Markets domestic staff reach out to clients and counsel companies on advocacy services.

Program activities that support manufacturing:

Advocates: According to program officials, the center offers government-to-government support for qualified U.S. business interests and acts as a counterweight to foreign governments that advocate for their national

businesses. The intent of the advocacy, according to these officials, is to promote fairness in foreign markets. Engagement by U.S. government officials with overseas governments may take the form of official correspondence, focused meetings or in-person meetings, talking points in a bilateral meetings or dialogue, and/or press releases or meetings with foreign press.

Conducts market intelligence: The company seeking advocacy fills out a questionnaire to provide the Center with details of the project description, type of assistance requested, foreign government decision makers, and timeline. The Advocacy Center then verifies the information with the assistance and concurrence of the U.S. mission abroad.

Verifies that the companies adhere to the Foreign Corrupt Practices Act: According to program officials, companies seeking advocacy must sign the anti-bribery agreement attesting that they adhere to the Foreign Corrupt Practices Act.

Conducts due diligence: The Center conducts due diligence on the company seeking assistance to confirm that the company can conduct the service or provide the products needed to successfully compete for and complete the foreign project.

Makes a national interest determination: When the U.S. business contribution is less than 50 percent of the total value of the project, the following is considered: U.S. materials and equipment content, U.S. labor content, contributions to the U.S. technology base, and potential for follow-on business benefiting the U.S. economy.

Participates in interagency task force: The Secretary of Commerce chairs the interagency task force on commercial advocacy, which comprises 15 other federal agencies. The purpose of the task force is to provide increased support for U.S. exporters beyond traditional commercial advocacy and take a “whole of government” approach.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
		X

Source: GAO analysis of survey data. | GAO-17-240

Antidumping and Countervailing Duty Operations

Department of Commerce, International Trade Administration, Enforcement and Compliance

Funding for the Antidumping and Countervailing Duty Operations Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$35	100%
Fiscal Year 2015	$37	100%
Fiscal Year 2016	$14[a]	100%

Source: GAO survey of agency officials. | GAO-17-240

[a]This amount is the obligations as of February 2016.

Program Information Reported in Survey

Year program created: Not reported

Program category: Trade, Enforce trade laws and agreements and support policy formulation

Program description: The Antidumping and Countervailing Duty Operations program enforces the U.S. trade laws by conducting investigations, administrative reviews, new shipper reviews, sunset reviews, changed circumstances reviews, and scope and anti-circumvention inquiries. The program also assists in the defense of determinations made by the Enforcement and Compliance office in U.S. courts, the World Trade Organization, and in North American Free Trade Agreement dispute settlement panels, according to program officials. The program conducts investigations in response to U.S. industry petitions alleging that imports are being dumped or unfairly subsidized and that those imports are materially injuring, or threatening material injury to, competing U.S. industry.

Program activities that support manufacturing:

Administration and enforcement of the antidumping and countervailing duty laws: The Enforcement and Compliance Office investigates U.S. firms' claims that they are being injured by dumped or unfairly subsidized imports. If the final result of an investigation is affirmative and the International Trade Commission makes a final finding of injury, the Enforcement and Compliance Office will impose an order that requires importers of the merchandise make cash deposits equal to the estimated amount of dumping and/or subsidization.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
		X

Source: GAO analysis of survey data. | GAO-17-240

Domestic Field

Department of Commerce, International Trade Administration, Global Markets

Funding for the Domestic Field Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$44	40%
Fiscal Year 2015	$45	40%
Fiscal Year 2016	$48	40%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1980

Program category: Trade, Export promotion

Program description: The Domestic Field program includes a network of 108 U.S. Export Assistance Centers across the United States that focus primarily on the exporting needs of small and medium-sized businesses. At Assistance Centers, Domestic Field trade specialists help identify opportunities for U.S. exporters, clarify foreign regulations and standards, provide support to clients who have business disputes abroad or encounter foreign market barriers, and counsel U.S. companies on the best strategies to succeed in overseas markets. The Domestic Field also plays a primary role in educating U.S. firms about their rights, obligations, and opportunities in foreign markets, or of the assistance the International Trade and Investment Administration can provide in resolving their trade problems. Working with other International Trade and Investment Administration programs, the Domestic Field program organizes educational outreach programs to U.S. businesses and industry associations across the country.

Program activities that support manufacturing:

Providing export counseling to U.S. exporters or companies interested in exporting: The network of U.S. Export Assistance Centers includes 108 offices in 48 states and Puerto Rico that work with U.S. companies on a one-by-one basis, including manufacturers, to focus on their exporting needs and plans. This often involves customized assistance, including market identification, export mechanics, financing options, and partner identification.

Fee-based services: These services include matchmaking and vetting services, as well as single company promotions, to help connect U.S. manufacturers with opportunities overseas.

Trade show assistance: This includes counseling on-site, and facilitating business-to-business meetings.

Export training: It organizes trade promotion conferences as well as numerous webinars and seminars on all aspects of exporting for U.S. manufacturers. The Domestic Field also partners with the Manufacturing Extension Partnership program to deliver the ExporTech export training program in locations across the country. This intensive export education program is delivered to five to seven manufacturers at a time with the end goal being the development of an actionable exporting plan for each manufacturer.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Foreign-Trade Zones in the United States

Department of Commerce, International Trade Administration, Enforcement and Compliance

Funding for the Foreign-Trade Zones in the United States Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$1.8	37.5%
Fiscal Year 2015	$2	37.5%
Fiscal Year 2016	$0.7[a]	37.5%

Source: GAO survey of agency officials. | GAO-17-240

[a]This amount is the obligations as of February 29, 2016.

Program Information Reported in Survey

Year program created: 1934

Program category: Trade, Export promotion

Program description: According to program officials, the Foreign-Trade Zones program helps encourage commercial activity and value added at U.S. manufacturing and distribution facilities that compete with foreign alternatives by allowing delayed or reduced duty payments on foreign merchandise transferred from the zones, as well as other savings. Officials also stated that the Foreign-Trade Zones program can reduce costs through delayed or reduced duties, allow special entry procedures, and encourage activity closer to market. Reducing costs through the program can lead to more competitive U.S. operations, thereby helping to maintain U.S.-based activities and jobs. Program staff serve as the operational arm of the Foreign-Trade Zone Board, an interagency body chaired by the Secretary of Commerce. The Board was established to license and regulate foreign trade zones, and licenses primarily public or non-profit corporations to administer zones on a local level.

Program activities that support manufacturing:

Processing requests for manufacturing (production) authority: According to program officials, under the Board's regulations, companies may conduct manufacturing operations within foreign trade zones if they have obtained approval in advance. Officials stated that the Board approves requests for manufacturing authority under procedures and criteria delineated in the Board's regulations.

Pre-application counseling for manufacturing applicants: Companies

may conduct manufacturing operations within foreign-trade zones if they have obtained approval in advance from the Board. Specifically, the Board staff responds to questions presented via telephone or e-mail and reviews and provides feedback on draft requests submitted by potential applicants.

Education and outreach on potential for Foreign-Trade Zone manufacturing: Through information available on the Board's website and shared at industry events, the Board staff conducts education and outreach activities regarding potential benefits to manufacturers under the Foreign Trade Zone program.

Manufacturing Trends Addressed by the Program

The mission of the Foreign-Trade Zones program is broader than just manufacturing. Additionally, program officials explained that although not specifically targeting the manufacturing trends GAO identified, in 2012 the Foreign-Trade Zone Board completed a total overhaul of its regulations. They further stated that although the revised regulations dramatically streamline procedures for potential program users—including potential users that could fall under one or more of the manufacturing trends—that change was effective as of April 2012 and, therefore, fell outside GAO's 3-year scope of review. While the program may have addressed the three manufacturing trends in recent years, there is nothing explicit in the program design that is intended to address or affect these developments.

Hollings Manufacturing Extension Partnership

Department of Commerce, National Institute of Standards and Technology

Funding for the Hollings Manufacturing Extension Partnership Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$122	100%
Fiscal Year 2015	$145	100%
Fiscal Year 2016	Not reported	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1988

Program category: Innovation, Applied research and development

Program description: The Hollings Manufacturing Extension Partnership is a federal-state-industry partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts. The program consists of Manufacturing Extension Partnership Centers located across the country that work directly with local manufacturing communities to strengthen their competitiveness. Funding for the Centers is a cost-sharing arrangement consisting of support from federal, state, and local governments and fees charged to the manufacturing clients for services provided by the Centers.

Program activities that support manufacturing:
Technical assistance: This assistance helps companies with internal operations (manufacturing of products and the processes by which they are made, as well as those operations needed to run the business effectively and efficiently) and external opportunities needed to provide growth of the business (supply chain participation, sales and marketing).
Training: The partnership provides training to small and mid-size manufacturers that includes introductions to advanced manufacturing technologies and techniques (e.g., additive manufacturing, digital manufacturing, smart manufacturing, and robotics), lean manufacturing principles, lean accounting, lean office techniques, export readiness, technology scouting, technology-driven market intelligence, company growth and innovation, six sigma and other statistical quality measures, quality systems, rapid prototyping, as well as other topics. These trainings

may be conducted in conjunction with local community colleges and technical schools.

Support for Manufacturing Day: The program supports the annual Manufacturing Day to raise awareness for manufacturing and attract younger workers to manufacturing jobs.

Export assistance: The program partners with the U.S. Export Assistance Centers of the Department of Commerce (DOC) to deliver the ExporTech export training and consultation program in locations across the country. This intensive export education program includes peer counseling and is delivered to five to seven manufacturers at a time to develop an exporting plan for each manufacturer, according to agency officials.

Program Evaluations That Assessed Any Impact on the U.S. Manufacturing Sector

- Lipscomb, C.A. et al. (2015) Evaluating the Long-Term Effect of NIST MEP Services on Establishment Performance https://ideas.repec.org/p/cen/wpaper/15-09.html
- Youtie, Jan A. (2013). An evaluation of the MEP: A Cross Study Analysis. In 21st Century Manufacturing: The Role of Manufacturing Extension Partnership Program. National Research Council.
- Ordowich, C. (2012) Evaluating the Impact of MEP Services on Establishment Performance: A Preliminary Empirical Investigation https://ideas.repec.org/p/cen/wpaper/12-15.html

Source: GAO survey of agency officials. I GAO-17-240

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Industry Trade Policy and Analysis

Department of Commerce, International Trade Administration, Industry and Analysis

Funding for the Industry Trade Policy and Analysis Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$2	20%
Fiscal Year 2015	$2	20%
Fiscal Year 2016	Not reported	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2013

Program category: Trade, Enforce trade laws and agreements and support policy formulation

Program description: The Industry Trade Policy and Analysis program supports U.S. government trade policy formulation and negotiations by providing the trade and economic analysis and issue expertise needed to expand exports and foreign direct investment in the United States. The objectives are to benefit U.S. businesses and provide new opportunities to expand U.S. exports of goods and services. The program also serves as the primary source of trade data within ITA and is responsible for undertaking cross-sectoral economic analysis, such as the number of annual jobs supported by exports.

Program activities that support manufacturing:
Represent U.S. industry in trade negotiations: The program maximizes U.S. gains in trade negotiations by evaluating industry positions and foreign market access offers and recommending policy actions that best support the interests of U.S. industry.
Protect U.S. intellectual property: The program advances U.S. commercial interests on international intellectual property laws, policies, practices and assists U.S. companies to overcome intellectual property-related trade barriers.
Standards policy: The program addresses standards-related market access barriers and leads ITA's involvement in standards policy issues, which may include those important to U.S. manufacturers.
Economic analysis: The program evaluates potential economic effects of statutory and regulatory programs on trade-dependent industries, including those engaged in manufacturing.
Data programs: The program provides publicly accessible online trade and tariff information to help companies (including manufacturers) assess the market opportunities available for their products.

Manufacturing Trends Addressed By the Program
Many of the issues that the Industry Trade Policy and Analysis program cover touch on the three manufacturing issues GAO identified, but little of what the program produces is explicit to U.S. manufacturing. The program is targeted toward exporters, although these exporters are neither explicitly "U.S." companies or explicitly manufacturing firms. The program does not isolate the impact that it has on these trends, as its efforts are more broadly focused.

International Field

Department of Commerce, International Trade Administration, Global Markets

Funding for the International Field Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$103	40%
Fiscal Year 2015	$99	40%
Fiscal Year 2016	$88	40%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1980

Program category: Trade, Export promotion

Program description: The International Field program includes foreign service officers, locally engaged staff, and headquarters-based experts who advance U.S. commercial interests, identify opportunities for U.S. exports, clarify local regulations and standards, engage foreign government officials in commercial diplomacy to help resolve market access and/or trade compliance problems affecting U.S. exporters or investors, and counsel companies on the best strategies to succeed in overseas markets. The program assists companies of all sizes to identify target markets for entry or expansion and develop effective strategies to succeed in those markets. This includes bringing foreign buyers and U.S. companies together through business matchmaking services, promotional support and representation at trade shows and fairs, trade events, product launches, and technical seminars.

Program activities that support manufacturing:
Technical assistance: The program provides pre-export logistics information and assistance, matchmaking with foreign companies, and on the ground advocacy on market access and/or compliance issues.

Manufacturing Trends Addressed by the Program		
Advanced manufacturing	**Higher skilled jobs**	**Globalization**
		X

Source: GAO analysis of survey data. | GAO-17-240

Investing in Manufacturing Communities Partnership

Department of Commerce, Economic Development Administration

Program Funding: The program is overseen by DOC, but DOC does not obligate additional funds specifically for the program. Instead, 12 federal agencies participating in the program and DOC provide funds to selected manufacturing communities through existing funding sources.

Program Information Reported in Survey
Year program created: 2013

Program category: General support across the areas of innovation, trade, and training

Program description: According to program officials, the Investing in Manufacturing Communities Partnership (IMCP) is designed to strengthen communities' ability to attract inbound investment by fostering regional collaboration and designating manufacturing communities to receive preferential consideration for federal funding, among other things. DOC has not allocated ongoing grant funding for this program because it was designed to enhance coordination and strategic investment of existing funding and technical assistance to manufacturing communities, according to agency officials. Benefits of the program include increasing capacity for U.S. innovation and manufacturing, higher skills for the American workforce, attracting and retaining small businesses that serve as suppliers, and expanding opportunity for U.S. exports.

Program activities that support manufacturing:
Providing grants: In September 2013, IMCP awarded $7 million in planning grants to 44 communities nationwide to support the development of their strategies. Under IMCP, 12 federal agencies and DOC with more than $1 billion in grant funding can use the awardees' plans to make targeted investments to strengthen regional manufacturing.
Technical assistance: To advance U.S. manufacturing and provide all communities with tools for success, DOC and the interagency team creates strategic programming and technical assistance opportunities.

Community Mentorship Program: The mentorship program aims to cultivate relationships among communities, create mutual vested interests, and encourage ownership in each other's success.
IMCP national summit: DOC hosts an annual manufacturing summit for manufacturing communities.
Federal liaison: The Economic Development Administration assigns each IMCP community to a federal liaison in one of the 13 partnering federal agencies.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
	X	X

Source: GAO analysis of survey data. | GAO-17-240

Manufacturing

Department of Commerce, International Trade Administration, Industry and Analysis

Program Funding: Not reported

Program Information Reported in Survey
Year program created: 2004

Program category: Trade, Export promotion

Program description: The Manufacturing program ensures appropriate industry and other stakeholder input into trade and investment policy development, as well as trade negotiations and implementation. Among other efforts, it supports exports and foreign direct investment in the United States by leveraging industry expertise and an understanding of the dynamics of global competition to develop and implement policies and improve U.S. business competitiveness globally in high-growth export sectors and markets and opportunities for foreign direct investment. The program develops industry-specific negotiating priorities for the U.S. government and develops and recommends strategies that further open foreign markets. The Manufacturing program also works closely with the Office of the United States Trade Representative in negotiating trade agreements and policy outcomes affecting these industries, providing key technical support. In addition, the Manufacturing unit analyzes and reports on potential benefits to U.S. producers and consumers, devises

programs to capitalize on opportunities, and supports compliance with trade agreement provisions.

Program activities that support manufacturing:
Export assistance (trade policy): The Manufacturing Unit works to develop trade policy positions that support the U.S. manufacturing sector and promote exports.
Export assistance (trade promotion): The Manufacturing Unit works to develop trade promotion activities for the U.S. manufacturing sector to promote exports.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Manufacturing USA

Department of Commerce, National Institute of Standards and Technology

Funding for the Manufacturing USA Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$0[a]	N/A
Fiscal Year 2015	$0[a]	N/A
Fiscal Year 2016	$25	100%

Source: GAO survey of agency officials. | GAO-17-240

[a]The existing Manufacturing USA institutes, as of November 2016, were funded and managed by the Departments of Defense and Energy, and the obligations for them are in those agencies' budgets and not included here.

Program Information Reported in Survey

Year program created: 2014

Program category: Innovation, Applied research and development

Program description: Manufacturing USA is a network of institutes where researchers, companies, and entrepreneurs can collaborate to develop new manufacturing technologies with broad applications. Each institute

has a unique technology focus and helps support manufacturing activity in local areas. The Manufacturing Innovation Institutes allow minimization of cost and risk to an industry in developing new manufacturing processes and technologies that take the nation's basic research to implementation in manufacturing, according to agency officials.

Program activities that support manufacturing:
Agency coordination: The network coordinates the activities of the program with programs and activities of other federal agencies whose missions contribute to or are affected by advanced manufacturing.
Network support: The network supports the institutes within the network with services to increase administrative efficiency and impact.
Open topic institutes: The Department of Commerce holds competitions for institutes where the topic is identified by industry via their proposals. It manages the institutes afterward.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Textiles, Consumer Goods, and Materials

Department of Commerce, International Trade Administration, Industry and Analysis

Program Funding: Not reported.

Program Information Reported in Survey
Year program created: 2013

Program category: Trade, Export promotion

Program description: The Textiles, Consumer Goods, and Materials program includes the Office of Textiles and Apparel and the Office of Consumer Goods and Materials. The Office of Textiles and Apparel administers and enforces agreements and preference programs concerning the textile, apparel, footwear, and travel goods industries and works to ensure fair trade and a level playing field for these industries to enhance their competitiveness in international markets. The office's promotion export program assists small and medium-sized U.S. textile and apparel firms to develop and expand their export markets, attempting

to help job retention and creation in this and related sectors. The Office of Consumer Goods and Materials provides industry expertise, trade policy guidance, and market access advocacy for a wide variety of consumer goods and materials industry sectors. Industry experts in the Office of Consumer Goods and Materials identify issues of strategic and commercial interest to those industry sectors and work with its stakeholders to enhance their international competitiveness.

Program activities that support manufacturing:
Policy advocacy and development: Program offices work with trade associations, companies, advisory committees, and individual companies to identify trade issues that need resolution so that U.S. industry is globally competitive. Activities include support for negotiation of trade agreements in concert with U.S. Trade Representatives and representation of U.S. policy and interests in bilateral and plurilateral trade for development of U.S. trade policy by objectively representing U.S. industry in internal U.S. government discussion.
Policy implementation: Program offices work with trade associations, companies, advisory committees, individual companies, and federal agencies to implement trade agreements and contribute to enforcement of trade agreements through work with industries and provide technical expertise on industry-related issues that are essential to developing policy and strategy for consultations and dispute settlement.
Trade promotion: Program offices work with trade associations, companies, and state and local governments to promote exports of U.S. textile, apparel, footwear, and consumer goods products, as well as materials (e.g., chemicals, building products, cosmetics, aluminum, and forest products). The program promotes products through trade missions, trade shows, International Buyer Programs, certified trade fairs, and Market Development Cooperator Program awards.
Technical assistance: The program provides U.S. industries with data and market analysis so companies can make better strategic decisions about exports and trade in general and counsels companies on foreign market conditions and trends based on trade data and qualitative analysis.
Administer cooperative agreements: Program offices currently administer seven Market Development Cooperative Programs, most of which are aimed at entry or expansion in key and growing markets (e.g., China).

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Trade Adjustment Assistance for Firms

Department of Commerce, Economic Development Administration

Funding for the Trade Adjustment Assistance for Firms Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$8	96%
Fiscal Year 2015	$20	100%
Fiscal Year 2016	$13	98%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1965

Program category: Trade, Financial support

Program description: According to agency officials, the Trade Adjustment Assistance for Firms program is a trade remedy mechanism that is used rather than relying on tariffs, quotas, or duties. This assistance targets U.S. firms experiencing a decline in sales and employment, resulting directly from the increase in imports of like or directly competitive articles. The program works in partnership with a national network of Trade Adjustment Assistance Centers, and provides technical assistance to U.S. manufacturing, production, and service firms affected by import competition to develop and implement projects to regain global competitiveness, increase profitability and create jobs.

Program activities that support manufacturing:
Petitioning for certification: The program assists firms with submitting a petition to be certified as a trade-impacted firm. Generally, certification specialists in the Trade Adjustment Assistance Centers work with the firm at no cost to the firm to complete and submit a petition.

Program Evaluations That Assessed Any Impact on the U.S. Manufacturing Sector

- *Trade Adjustment Assistance: Commerce Program Has Helped Manufacturing and Services Firms, but Measures, Data, and Funding Formula Could Improve*. GAO-12-930. Washington, D.C.: September 13, 2012.

Source: GAO survey of agency officials. I GAO-17-240

Recovery planning: The program-certified firms work with Trade Adjustment Assistance Centers staff to develop a customized business recovery plan for approval.
Recovery plan implementation: The firm works with consultants to implement projects in an approved business recovery plan.
Providing grants: The program provides grants to independent, non-profit or university-affiliated Trade Adjustment Assistance Centers that help U.S. manufacturing, production, and manufacturing service firms in a public-private collaborative framework apply for certification of eligibility for program assistance and prepare and implement strategies to guide firms' economic recovery.
Technical assistance: The program provides direct technical assistance to import-impacted U.S. manufacturing, production, and service firms by providing matching funds to Trade Adjustment Assistance Centers. The centers use the funds to match the costs for third-party consultants to help firms expand markets, strengthen operations, and increase competitiveness.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
		X

Source: GAO analysis of survey data. | GAO-17-240

Trade Enforcement and Compliance Policy and Negotiations

Department of Commerce, International Trade Administration, Enforcement and Compliance

Funding for the Trade Enforcement and Compliance Policy and Negotiations Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$23	Not reported
Fiscal Year 2015	$24	Not reported
Fiscal Year 2016	Not reported	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey
Year program created: 2013

Program category: Trade, Enforce trade laws and agreements and support policy formulation

Program description: The Policy and Negotiations program oversees a variety of activities and policies related to the negotiation of trade and investment disciplines in international agreements, the administration of U.S. antidumping and countervailing duty laws, the negotiation and administration of suspension agreements of U.S. antidumping and countervailing duty investigations, as well as the improvement of access to export markets for U.S. companies.

Program activities that support manufacturing:
Trade agreements negotiation and compliance: The program office negotiates trade and investment international agreements, conducts outreach and assistance to U.S. companies or industries confronting foreign government trade actions or barriers that block or impede U.S. exports or investment, and administers the Trade Agreements Compliance Program, which involves all business units in ITA and the Office of the General Counsel.
Antidumping and Countervailing Duties Petition Counseling and Analysis Unit: This program office reaches out to and assists U.S. industries and workers (especially small and medium-sized enterprises) seeking to use U.S. antidumping and countervailing duty law to remedy injury from unfairly traded imports.
Support antidumping and countervailing duty cases: A program office applies policies and procedures in antidumping/countervailing duty proceedings while ensuring that broader policy objectives and statutory and international obligations are respected. They assist U.S. businesses by reviewing case determinations and developing new policies for major or emerging issues and ensuring consistent application of the trade remedy laws.
Trade remedy compliance: Staff monitor and conduct outreach and advocacy to address potentially unfair application of foreign trade remedies. Staff members provide a wide range of services and tools to assist U.S. companies that find themselves subject to trade remedy actions.
Subsidies Enforcement Office: This office assists U.S. businesses by providing a range of services to confront foreign subsidies that impede U.S. companies' and workers' ability to compete and expand into domestic as well as overseas markets.

Steel import monitoring and analysis: The office administers the Steel Import Licensing program and provides steel import statistics and analyses to the U.S. government and industry stakeholders.
Interagency Trade Enforcement Center: The office provides expert support to trade enforcement undertakings by the U.S. government, including research on foreign laws and measures.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
		X

Source: GAO analysis of survey data. | GAO-17-240

Basic, Applied, and Advanced Research in Science and Engineering

Department of Defense, Office of the Secretary

Program Funding: Not reported

Program Information Reported in Survey
Year program created: Not reported

Program category: Innovation, Basic research and development

Program description: The Basic, Applied, and Advanced Research in Science and Engineering program (1) supports basic, applied, or advanced research and technology development in mathematical, physical, engineering, environmental, and life sciences, in addition to other fields with good, long-term potential for contributing to technology for Department of Defense missions; (2) facilitates transition of research results to practical application for defense needs; (3) improves linkages between defense research and the civilian technology and industrial bases to promote commercial application of the results of defense research and commercial availability of technology for defense needs; (4) fosters education of future scientists and engineers in disciplines critical to defense; and (5) strengthens the infrastructure for research and related science and engineering education in those disciplines.

Program activities that support manufacturing:
Technology maturity: The program invests in emerging manufacturing processes for enabling defense technologies required for national defense.

Industrial base: The program actively supports a connected U.S. defense industrial base.
Infrastructure: The program actively supports a healthy defense infrastructure.
Workforce: The program actively supports an educated workforce to support national defense.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Commercial Technologies for Maintenance Activities

Department of Defense, Office of the Assistant Secretary of Defense for Logistics Maintenance and Readiness

Program Funding: Not reported

Program Information Reported in Survey
Year program created: 1998

Program category: Innovation, Applied research and development

Program description: The Commercial Technologies for Maintenance Activities program is a joint Department of Defense (DOD)/National Centers for Manufacturing Science effort that promotes collaborative technology development, demonstration, and transition within DOD. Its objective is to ensure American troops and their equipment are ready to face any situation, with the most up-to-date and best-maintained platforms and tools available. The program is based on a collaborative model for manufacturers, academia, and DOD, and it creates relationships and opportunities, drives cutting edge research and development, and conducts industry intelligence from a unique perspective. Through partnerships, training, software, and business operations, the program can help achieve industry objectives while satisfying DOD needs through demonstration of new technologies prior to full deployment.

Program activities that support manufacturing:
Facilitates industry and DOD collaboration regarding maintenance technology: On occasion, the program advances maintenance capabilities that have directly benefited the manufacturing industrial base due, in part, to a large overlap between manufacturing technologies used by original equipment manufacturers and the tools and procedures employed by DOD maintenance depots. Examples of these capabilities include advanced machine controls, additive manufacturing and repair, complex electronics testing and troubleshooting, product lifecycle management applications, and advanced welding techniques, among other things.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Defense Production Act Title III

Department Of Defense, Office of Manufacturing and Industrial Base Policy

Funding for the Defense Production Act Title III Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$157	100%
Fiscal Year 2015	$204	100%
Fiscal Year 2016	Not reported	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1950

Program category: General financing

Program description: According to agency officials, when essential to the national defense, Title III authority enables the U.S. government to apply financial incentives to encourage private industry to create new domestic sources of supply for key advanced materials and technology items and

to accelerate deployment of new product and manufacturing process technology. According to agency officials, Title III authorities may be employed when domestic industrial capabilities that impact essential government requirements do not exist, are at risk of being lost, or are insufficient to meet essential governmental needs. According to agency officials, Title III actions stimulate private investment in production resources by reducing the risks associated with the capitalization and investments required to establish the needed production capacity. Projects range from process improvements and emerging technologies to construction of complete industrial production facilities.

Program activities that support manufacturing:
Purchase and develop production capabilities: The program purchases for government use or resale to create, maintain, protect, expand, or restore domestic industrial base capabilities essential for the national defense.
Installation of equipment in industrial facilities: The program purchases, installs, and transfers title of production equipment.
Purchase commitments: The program guarantees market to incentivize companies to establish production capability.
Loans/loan guarantees: According to agency officials, the President may authorize a guaranteeing agency to provide guarantees of loans by private institutions to finance any contractor, subcontractor, provider of critical infrastructure, or other person in support of production capabilities or supplies that are necessary to the national defense to reduce current or projected shortfalls of industrial resources, critical technology items, or essential materials needed for national defense purposes.
Development of substitutes: The program strengthens the production and technological capabilities of key industrial sectors and ensures affordable and assured access to critical materials and technologies.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Industrial Base Analysis and Sustainment Program

Department Of Defense, Office of Manufacturing and Industrial Base Policy

Funding for the Industrial Base Analysis and Sustainment Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$10	100%
Fiscal Year 2015	$15	100%
Fiscal Year 2016	$23	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2014

Program category: Innovation, Applied research and development

Program description: The Industrial Base Analysis and Sustainment program provides the Department of Defense with a comprehensive ability to monitor and assess the industrial base, to address critical issues relating to urgent operational needs and industrial base vulnerabilities, and to support industrial base expansion. This program maintains or improves the health of critical and fragile industry capabilities that are at risk of being lost but are needed to support the National Defense Strategy. The goal of the program is to avoid loss of critical capabilities and resultant reconstitution costs wherever affordable; innovative mechanisms are available to the producers in the interim.

Program activities that support manufacturing:
Contracts: The program funds contracts with constituents of the National Technology and Industrial Base for specific at-risk goods and services to address critical issues in the industrial base, expand the industrial base, and address defense supply chain vulnerabilities.
Minimize risks to industrial base: The program supports the warfighter by minimizing risks from industrial base capability issues.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Manufacturing Applied Research

Department of Defense, Navy

Funding for the Manufacturing Applied Research Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$1	100%
Fiscal Year 2015	$1	100%
Fiscal Year 2016	$1	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: Fiscal Year 2014

Program category: Innovation, Applied research and development

Program description: The Manufacturing Applied Research program supports innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on advanced Naval materials, biocentric technologies, environmental quality, human factors and organizational design, medical technologies, and Naval training technologies.

Program activities that support manufacturing:
Providing contracts: The program contracts for technical work in manufacturing applied research.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Manufacturing Experimentation and Outreach Two (MENTOR2)

Department of Defense, Defense Advanced Research Projects Agency, Defense Science Office

Funding for the Manufacturing Experimentation and Outreach Two Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$11	100%
Fiscal Year 2015	$0	N/A
Fiscal Year 2016	$0	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2014

Program category: Training, Enhancing job seekers' skills

Program description: The Manufacturing Experimentation and Outreach Two (MENTOR2) program seeks to enhance defense readiness by improving both the training and the tools available to those who will be called on to utilize, maintain, and adapt high-technology systems in low-technology environments. The program pursues this goal by developing and demonstrating new training tools, new materials, and new manufacturing technologies in the fields of electromechanical design and manufacturing. It is envisioned that project-based curricula employing MENTOR2 design and prototyping tools will teach a deeper understanding of high-technology systems and better enable future competence in maintaining and adapting such systems through the manufacture of as-designed components or the design and manufacture of new components.

Program activities that support manufacturing:
Training: The program develops instructor-led and independent training (along with supporting materials/equipment) to Department of Defense personnel to support understanding and hands-on experience with prototyping equipment, computer-aided design, and simulation systems.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Manufacturing Technology Program

Department of Defense, Office of Manufacturing and Industrial Base Policy

Funding for the Manufacturing Technology Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$226	100%
Fiscal Year 2015	$191	100%
Fiscal Year 2016	$27	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: more than 50 years ago

Program category: Innovation, Applied research and development

Program description: The Manufacturing Technology Program focuses on the needs of the warfighter and weapons systems by helping to implement affordable, low-risk manufacturing solutions. The program provides a crucial link between technology and industrial base applications; matures and validates emerging manufacturing technologies to support affordable, timely, and low-risk implementation in industry; and addresses production issues from system development through transition to production sustainment. In addition, this program funds the Department of Defense-led Manufacturing USA institutes.

Program activities that support manufacturing:
Technology maturity: The program invests in emerging manufacturing processes for enabling defense technologies required for national defense.
Industrial base: The program actively supports a connected U.S. defense industrial base.

Infrastructure: The program actively supports a healthy defense infrastructure.
Workforce: The program actively supports an educated workforce to support national defense.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Navy Manufacturing Science

Department of Defense, Navy

Funding for the Navy Manufacturing Science Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$2	100%
Fiscal Year 2015	$0.8	100%
Fiscal Year 2016	$0.8	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: Fiscal Year 2009

Program category: Innovation, Basic research and development

Program description: The Navy Manufacturing Science program addresses basic research efforts including scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences.

Program activities that support manufacturing:
Providing grants: The program awards grants to research institutions to carry out research in novel manufacturing and process control technologies.

Manufacturing Trends Addressed by the Program		
Advanced manufacturing	**Higher skilled jobs**	**Globalization**
X		

Source: GAO analysis of survey data. | GAO-17-240

Prototype Integration Facilities

Department of Defense, Army, Research, Development, and Engineering Command

Program Funding: Not reported

Program Information Reported in Survey
Year program created: 2012

Program category: Innovation, Applied research and development

Program description: Prototype Integration Facilities are buildings where engineers develop and test various manufacturing products and generate related data to help meet warfighter needs. The facilities assist in the transition of technologies from the laboratory to the field. The specific core mission and related competencies of each prototype integration facility is unique depending upon the engineering support required by their specific customers.

Program activities that support manufacturing:
Execute Army Manufacturing Technology Program: The Army Manufacturing Technology program addressed manufacturing technology gaps. When developing Army weapon systems, the facilities identify manufacturing technology gaps and develop manufacturing processes to promote affordability. Prototype integration facilities execute this work using in-house facilities and in collaboration with industry. The facilities are able to transfer manufacturing technologies to both the commercial and organic industrial base using a variety of contracting instruments and agreements.
Training: The program provides training to organic industrial base personnel in newly developed manufacturing processes (e.g., welding of titanium) and provides specialized training in manufacturing technologies for Army personnel.
Manufacturing technology transfer: The program validates engineering data through manufacturing prototypes and captures manufacturing process data. The program also makes these data available to the

organic and commercial industrial base.
Cooperative research and development agreements: The program works directly with industry to develop and transition new manufacturing technologies.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	

Source: GAO analysis of survey data. | GAO-17-240

Career and Technical Education—Basic Grants to States

Department of Education, Office of Career, Technical, and Adult Education

Funding for the Career and Technical Education—Basic Grants to States Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$1,116	Not reported[a]
Fiscal Year 2015	$1,116	Not reported[a]
Fiscal Year 2016	$777	Not reported[a]

Source: GAO survey of agency officials. | GAO-17-240

[a]Agency officials were unable to estimate the percentage used to support manufacturing.

Program Information Reported in Survey

Year program created: 1984

Program category: Training, Enhancing job seekers' skills

Program description: The Career and Technical Education—Basic Grants to States program helps develop the academic, career, and technical skills of secondary and postsecondary students who elect to enroll in career and technical education programs.

Program activities that support manufacturing:
Providing grants: Grant recipients and subrecipients may use grant funds to improve programs that prepare individuals for careers in manufacturing. The decision to use grant funds for this purpose is made by the recipient and subrecipient. About 5 percent of students

concentrated in manufacturing in program year 2010-2011, according to officials from the Department of Education.[1]

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
	X	

Source: GAO analysis of survey data. | GAO-17-240

Career and Technical Education—National Programs

Department of Education, Office of Career, Technical, and Adult Education

Funding for Career and Technical Education—National Programs

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$7	2%
Fiscal Year 2015	$6	Not reported[a]
Fiscal Year 2016	$1.8	Not reported[a]

Source: GAO survey of agency officials. | GAO-17-240

[a]Agency officials were unable to estimate the percentage used to support manufacturing.

Program Information Reported in Survey

Year program created: 1984

Program category: Training, Enhancing job seekers' skills

Program description: The Career and Technical Education—National Programs provide support directly—or through grants, contracts, or cooperative agreements—for research, development, demonstration, dissemination, evaluation, assessment, capacity-building, and technical assistance activities aimed at improving the quality and effectiveness of *career and technical education programs.*

[1]U.S. Department of Education, Office of Career, Technical, and Adult Education, *Carl D. Perkins Career and Technical Education Act of 2006: Report to Congress on State Performance, Program Year 2010-2011*. Washington, D.C., 2014.

Program activities that support manufacturing:
Technical assistance: In 2015, program funds were used to support a series of webinars ("Skills on Purpose") to provide technical assistance to those seeking to build the education and skills of the manufacturing workforce through partnerships between educational institutions and industry.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
	X	

Source: GAO analysis of survey data. | GAO-17-240

Advanced Manufacturing Office

Department of Energy, Office of Energy Efficiency and Renewable Energy

Funding for the Advanced Manufacturing Office

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$72	100%
Fiscal Year 2015	$196	100%
Fiscal Year 2016	$174	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2011

Program category: Innovation, Applied research and development

Program description: The mission of the Advanced Manufacturing Office is to reduce the energy intensity and life-cycle energy consumption of manufactured products by researching, developing, and demonstrating energy-efficient manufacturing processes and materials and to promote continuous improvement in energy efficiency among existing facilities and manufacturers. Its goal is to reduce energy consumption of manufactured goods across targeted product life-cycles by 50 percent over 10 years.

Program activities that support manufacturing:

Research and development facilities: The program works with National Laboratories to competitively select research, development, and demonstration activity investments in foundational energy-related advanced manufacturing technologies through large scale public-private consortia. As noted previously, the program also oversees and funds Department of Energy institutes under the Manufacturing USA program.

Research and development projects: These projects support innovative, clean-energy manufacturing projects cost-shared with companies and research organizations that focus on specific high-impact manufacturing technology materials and process challenges. These activities fund the development of next-generation manufacturing materials, information, and process technologies that facilitate the transition of emerging clean energy technologies to domestic production and improve energy efficiency in energy-intensive and energy-dependent manufacturing processes.

Technical assistance: The program provides critical technical assistance for the deployment of advanced energy efficiency technologies and practices. Technical assistance activities help individual manufacturers reduce their energy intensity by 25 percent over 10 years; demonstrate the viability of improved energy management approaches; and provide targeted energy efficiency, productivity, and waste/water use reduction technical assistance to small and medium-sized manufacturers.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Advanced Technology Vehicles Manufacturing Loan Program

Department of Energy, Loan Program Office

Funding for the Advanced Technology Vehicles Manufacturing Loan Program

	Reported obligations, in millions[a]	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$5	0%[b]
Fiscal Year 2015	$4	100%
Fiscal Year 2016	$13	0%[c]

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are reported obligations for the program's administrative costs. These are funds for originating, evaluating, and monitoring direct loans. The program also has funds for direct loans. These funds are used to provide direct loans to borrowers and are not included here.

[b]In fiscal year 2014, the program did not make any loan or credit subsidy obligations.

[c]In fiscal year 2016, no loan or credit subsidy obligations had been made as of March 25, 2016.

Program Information Reported in Survey

Year program created: 2007

Program category: General financing

Program description: The Advanced Technology Vehicles Manufacturing loan program was established to support the production of fuel-efficient, advanced technology vehicles and qualifying components in the United States. The purpose is to originate, underwrite, and service loans to eligible automotive manufacturers and component manufacturers to finance the cost of (1) re-equipping, expanding, or establishing manufacturing facilities in the United States to produce advanced technology vehicles and qualifying components and (2) engineering integration performed in the United States of advanced technology vehicles and qualifying components.

Program activities that support manufacturing:

Provides direct loans to automotive or component manufacturers: The program provides direct loans to automotive manufacturers and component suppliers to support domestic manufacturing of fuel-efficient, advanced technology vehicles and qualifying components.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Bioenergy Technologies Office

Department of Energy, Office of Energy Efficiency and Renewable Energy

Funding for the Bioenergy Technologies Office

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$124	100%
Fiscal Year 2015	$109	100%
Fiscal Year 2016	$193	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1992

Program category: Innovation, Applied research and development

Program description: The Department of Energy's Bioenergy Technologies Office forms cost-share partnerships with key stakeholders to develop, demonstrate, and deploy technologies for advanced biofuels production. The program works with industrial, academic, national laboratory, agricultural, and nonprofit partners to develop and deploy commercially viable, high-performance and sustainable biofuels, biproducts, and biopower from renewable biomass resources in the United States to reduce dependence on imported oil, enhance energy security, create domestic jobs, improve ecosystem health, and reduce carbon emissions.

Program Evaluations That Assessed Any Impact on the U.S. Manufacturing Sector

- U.S. Department of Energy, Energy Efficiency & Renewable Energy, Bioenergy Technologies Office, 2013 Review Panel Summary Report and Program Results, DOE/EE-1014 (2014).
- U.S. Department of Energy, Energy Efficiency & Renewable Energy, Bioenergy Technologies Office, 2015 Review Panel Summary Report and Program Results, DOE/EE-1386 (2016).

Source: GAO survey of agency officials. I GAO-17-240

Program activities that support manufacturing:

Competitive research and development awards: The program regularly issues funding opportunity announcements that target research and development needs identified through workshops with industry and academia, which identify key technical barriers to commercialization of biofuel and enabling technologies.

Competitive pilot and demonstration awards: The program regularly issues funding opportunity announcements designed to provide financial assistance to industry in construction of pilot and demonstration facilities.

National laboratory research and development: The program directly funds research and development on applied and enabling technology at several national laboratories with core and key capabilities to address cross-cutting technical barriers.

Enhancing sustainability of bio-based systems: The program's sustainability activities include analysis and research and development focused on understanding and promoting the positive environmental, economic, and social effects and reducing the potential negative impacts of bioenergy production activities. Efforts include developing scientific methods and models for measuring bioenergy sustainability across the full supply chain, demonstrating improved environmental performance and social benefits relative to conventional or business-as-usual energy systems, and disseminating practical tools for analyses and technology development that enhance sustainable bioenergy outcomes.

Resource assessment: The program's resource assessment work uses a comprehensive spatially-explicit modeling framework to estimate county-level supply curves for all major traditional crop and biomass feedstock resources, including energy crops. In fiscal year 2015, the focus was on the analysis of the current and future economic availability of biomass feedstocks.

Workforce development: The program is developing and will implement an education and workforce development program to improve public accessibility to information on bioenergy production and the bioenergy industry, support formal and informal education including STEM and vocational programs in exploring issues relevant to sustainable production of biofuels and bioproducts, and develop and enhance pathways to bioenergy-related training and careers.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Clean Energy Manufacturing Initiative

Department of Energy, Office of Energy Efficiency and Renewable Energy

Program Funding: This initiative is a crosscutting activity leveraging other programs' funded activities, according to Department of Energy (DOE) officials.

Program Information Reported in Survey
Year program created: 2013

Program category: Innovation, Applied research and development

Program description: The Clean Energy Manufacturing Initiative is an effort across DOE to strengthen U.S. clean energy manufacturing competitiveness. The objectives are to increase U.S. competitiveness in manufacturing clean energy technologies and increase U.S. manufacturing competitiveness across the board by boosting energy productivity and leveraging low-cost domestic energy resources and feedstocks.

Program activities that support manufacturing:
Analysis: The program provides objective analysis and up-to-date data on global clean energy manufacturing.
Public-private partnership pilots: As a part of its mission, the program builds partnerships to increase U.S. manufacturing competitiveness. DOE currently supports partnership efforts across the country through a range of pilots, initiatives, institutes, and facilities.
Engagement and communications: The program engages leaders from industry, universities, national laboratories, and the broader innovation and economic community to identify ways in which the public and private sectors can partner to enhance U.S. clean energy competitiveness. For advancing clean energy manufacturing, the program engages stakeholders through regional and national summits and through new partnerships. Further, at Clean Energy Manufacturing Initiative Days, leaders from the Department of Energy and the participating manufacturing companies discuss manufacturing technology research and development priorities and strategies for increasing U.S. manufacturing competitiveness.
Crosscutting coordination: The program coordinates the Clean Energy Manufacturing Tech Team. The team formulates and develops a strategy to leverage existing budget authorities to strengthen U.S. clean energy manufacturing competitiveness and advance progress toward the nation's energy goals.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Concentrating Solar Power

Department of Energy, Office of Energy Efficiency and Renewable Energy, Solar Energy Technology Office

Funding for the Concentrating Solar Power Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$15	75-100%
Fiscal Year 2015	$49	75-100%
Fiscal Year 2016	$20	75-100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1977

Program category: Innovation, Applied research and development

Program description: The Concentrating Solar Power program provides competitive awards to industry, national laboratories, and universities with the shared goal of making large-scale dispatchable solar energy systems cost competitive without subsidies by the end of the decade. As part of this effort, the program supports research and development of concentrated solar power technologies to achieve SunShot Initiative cost targets, which seeks to make solar energy more affordable by using systems that can supply solar power on demand through the use of thermal storage.

Program activities that support manufacturing:
Funding opportunity announcements: The program provides financial assistance for research, development, and demonstration to assist in getting technology to market.
Workshops/conferences: The program holds and participates in workshops and conferences to stimulate discussion of the market, trends, priorities, and to identify opportunities, among other things.

Technical assistance: The program provides technical assistance to awardees during the course of projects.
Interagency collaboration: The program collaborates with other agencies to perform studies of potential environmental impacts of the technologies.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Photovoltaics

Department of Energy, Office of Energy Efficiency and Renewable Energy, Solar Energy Technology Office

Funding for the Photovoltaics Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$58	10%
Fiscal Year 2015	$27	10%
Fiscal Year 2016	$51	30-40%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2012

Program category: Innovation, Applied research and development

Program description: The Photovoltaics program specifically supports the research and development of photovoltaics technologies to improve efficiency and reliability and to lower manufacturing costs to make solar electricity cost-competitive with other sources of energy.

Program activities that support manufacturing:
Providing cooperative assistance: The program funds research and development activities that, if successful, are intended to transition to domestic manufacturing.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
	X	

Source: GAO analysis of survey data. | GAO-17-240

Solid State Lighting Program

Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office

Funding for the Solid State Lighting Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$23	25-50%
Fiscal Year 2015	$23	25-50%
Fiscal Year 2016	$23	25-50%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2005

Program category: Innovation, Applied research and development

Program description: The Solid State Lighting Program focuses on research and development breakthroughs in efficiency and performance of solid-state lighting technology, and it equips buyers to successfully apply solid-state lighting. The program includes the following elements: (1) core technology research projects focused on applied research for technology development, with particular emphasis on meeting efficiency, performance, and cost targets; (2) product development projects that use the knowledge gained from basic or applied research to develop or improve commercially viable materials, devices, or systems; (3) manufacturing research and development projects to reduce costs and enhance quality in solid-state lighting products and to address the technical challenges that must be overcome to enable solid-state lighting to compete with existing lighting on a first-cost basis; and (4) technology application research and development projects to monitor solid-state lighting technology advances and provide field and laboratory evaluations of emerging products, particularly LED lighting systems that involve advanced controls. Technology application research and development

projects address broad issues related to technology performance with a view that spans the entire industry.

Program activities that support manufacturing:
Financial assistance agreements for research and development: The program provides financial assistance for competitive research and development to maximize the energy-efficiency of solid-state lighting products in the marketplace; remove market barriers by improving lifetime, color quality, and lighting system performance; reduce costs of solid-state lighting sources and luminaires; improve product consistency while maintaining high-quality products; and encourage the growth, leadership, and sustainability of domestic U.S. manufacturing within the solid-state lighting industry. Applicants seeking assistance must submit a manufacturing plan that includes substantial domestic manufacturing.
Email postings: The program disseminates information that focuses on solid-state lighting companies manufacturing in the United States, in a series called “SSL [solid-state lighting] in America.” This is not intended to endorse or promote any of the companies, but rather to describe advances in energy-efficient solid-state lighting.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Tech-to-Market

Department of Energy, Office of Energy Efficiency and Renewable Energy, Solar Energy Technology Office

Funding for the Tech-to-Market Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$31	50-75%
Fiscal Year 2015	$42	50-75%
Fiscal Year 2016	$75	Not reported[a]

Source: GAO survey of agency officials. | GAO-17-240

[a]Agency officials were unable to estimate the percentage used to support manufacturing.

Program Information Reported in Survey

Year program created: 2012

Program category: Innovation, Applied research and development

Program description: The Tech-to-Market program within the Solar Energy Technology Office aims to make solar energy more cost-competitive. The program helps move technologies to the market by targeting two known funding gaps: (1) those that occur at the prototype commercialization stage and (2) those at the commercial scale-up stage. The program funds recipients so that they are able achieve technical milestones and commercialize the funded technology, while also helping them to find follow-on funding and form strategic partnerships.

Program activities that support manufacturing:
Provide funding opportunities: The program provides funding opportunities to selected and awarded applicants who are working on cutting edge technology within the United States. The recipients must be working toward the Sunshot goal and contributing to the latest and greatest technologies in the solar industry.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Windows and Building Envelope

Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office

Funding for the Windows and Building Envelope Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$10	84%
Fiscal Year 2015	$2	0%
Fiscal Year 2016	$31	Not reported

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1974

Program category: Innovation, Applied research and development

Program description: The Windows and Building Envelope program research and development efforts focus on ways to reduce energy consumption in buildings by supporting projects that develop energy-efficient windows and envelope projects. Program activities address technologies like highly insulating materials and systems; methodologies and analysis tools to measure and validate building envelope performance; and market-enabling efforts, such as creating an organization to rate, certify, and label related products to better inform consumers.

Program activities that support manufacturing:

Competitively awarded research and development projects: The program provides funds to support research and development projects that include advanced manufacturing processes for energy-efficient window and building envelope components. The sub-program also provides earlier stage applied research and development funding for technologies that might indirectly impact the U.S. manufacturing sector, such as advanced window coatings or advanced insulation materials that could be adopted by U.S. manufacturers in the future.

Annual operating plan for Department of Energy national laboratories: The program provides direct funding to some national laboratories to support the development of physics-based software models of building envelope components, including windows, as well as facilities used by manufacturers to test the physical properties of building

envelope components. The sub-program also supports research and development projects at the national laboratories that have indirect impact on U.S. manufacturers as they have the potential to be incorporated in future manufacturing processes.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Centers for Innovation in Advanced Development and Manufacturing

Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response

Funding for the Centers for Innovation in Advanced Development and Manufacturing Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$0	N/A
Fiscal Year 2015	$20	100%
Fiscal Year 2016	$21	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2012

Program category: Manufacturing public health products

Program description: The Centers for Innovation in Advanced Development in Manufacturing is a core service that provides advanced development and manufacturing capabilities for developing medical countermeasures for emerging infectious diseases; chemical, biological, radiological, and nuclear threats; as well as the manufacturing of pandemic influenza vaccine doses augmenting the current national capacity. The Centers will increase the nation's preparedness for bioterrorism and influenza pandemic by using modern technologies for accelerating production, improving quality, and expanding vaccine manufacturing capacity. The Centers are comprised of three companies that provide advanced development and manufacturing capabilities.

Program activities that support manufacturing:

Funding for manufacturing sites: The program is currently funding the establishment and operation of domestic manufacturing sites located in Baltimore, MD; Holly Springs, NC; and College Station, TX.

Workforce training and development: Aside from providing core services for the advanced development and manufacture of biological medical countermeasures, this program supports the creation or enhancement of specialized workforce training and development approaches to reestablish the U.S.-based expertise necessary for developing and producing chemical, biological, radiological, and nuclear medical countermeasures. These approaches are intended to develop a highly-skilled biotechnology and pharmaceutical workforce proficient in bioprocess engineering, production, quality systems, and regulatory affairs.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Fill Finish Manufacturing Network

Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response

Funding for the Fill Finish Manufacturing Network Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$0	N/A
Fiscal Year 2015	$13	100%
Fiscal Year 2016	$0.4	50-100%[a]

Source: GAO survey of agency officials. | GAO-17-240

[a]According to agency officials, as of December 2016, half of the 2016 obligations may be disbursed in the future to non-US manufacturing contractors, dependent on task orders awarded in the next 5 years, though all 100 percent could support U.S. manufacturing.

Program Information Reported in Survey

Year program created: 2013

Program category: Manufacturing public health products

Program description: The Fill Finish Manufacturing Network provides packaging support for medical countermeasure distribution. The program is comprised of four companies that are industry experts in the area of filling and finishing bulk products into sterile vials, syringes, and cartridges. They also complete the kitting, labeling, and packaging services as needed. These four companies maintain commercial clients and perform these services on a routine basis. As members of the network, they can respond to U.S. government funded project needs where a product developer does not have these capabilities in-house.

Program activities that support manufacturing:
Domestic manufacturing capacity: The four providers of the biological fill and finish manufacturing services maintain a significant domestic capacity. Facilities exist in Alachua, FL; Bloomington, IN; Rochester, MI; and Greenville, NC.
Addressing critical sterile drug shortage concerns: In collaboration with the Food and Drug Administration, the Department of Health and Human Services has engaged contractors in the Fill Finish Manufacturing Network to manufacture and transfer specific sterile drug products found on the drug shortage list. The intent is to train the network to perform an effective and efficient manufacturing technical transfer for any sterile drug product, along with all the quality and regulatory administration tasks that would be required in a public health emergency. This pilot program has the added benefit of potentially alleviating sterile drug shortage concerns by increasing domestic capacity.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

National Occupational Research Agenda Manufacturing Sector

Department of Health and Human Services, National Institute for Occupational Safety and Health

Funding for the National Occupational Research Agenda Manufacturing Sector Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$291	11%
Fiscal Year 2015	$297	10%
Fiscal Year 2016	$301	9%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2006

Program category: Innovation, Applied research and development

Program description: The mission of the program is to eliminate occupational injuries, illnesses, hazardous exposures, and fatalities among individuals working in manufacturing through a focused program of research, intervention, and prevention. Program officials also co-chair the Manufacturing Sector Council, which has representatives from academia, trade/professional organizations, industry, insurers, unions, and government. This Council is charged with maximizing the impact of occupational safety and health research through partnerships and to promote widespread adoption of improved workplace safety and health practices based on research findings.

Program activities that support manufacturing:
Research: The program helps generate new knowledge on occupational safety and health through an intramural/research program; develop innovative solutions for difficult-to-solve problems in high-risk industrial sectors; and track work-related hazards, exposures, illnesses and injuries for prevention.
Provide grants: The program provides grants to extramural investigators to conduct research on occupational safety and health. These investigators generate new knowledge and test the efficacy of innovative solutions.
Training: The program builds capacity to address traditional and emerging hazards through training.

Information dissemination: The program delivers occupational safety and health communication to inform decisions towards safe work practices and to improve workplace safety and health.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

H-1B Jobs Training Grants

Department of Labor, Employment and Training Administration

Funding for the H-1B Jobs Training Grants Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$117	33%
Fiscal Year 2015	$250	62%
Fiscal Year 2016	$380	59%[a]

Source: GAO survey of agency officials. | GAO-17-240

[a]This is the reported percentage of grant project funds awarded in FY 2016 that supported training in advanced manufacturing.

Program Information Reported in Survey

Year program created: 1998

Program category: Training, Enhancing job seekers' skills

Program description: The H-1B Job Training Grant Program funds projects that provide training and related activities to assist workers in gaining the skills and competencies needed to obtain or upgrade employment in high-growth industries or economic sectors. Over time, these education and training programs will help businesses reduce their use of skilled foreign professionals permitted to work in the U.S. on a temporary basis under the H-1B visa program.

Program activities that support manufacturing:
Funding training through grants: The program competitively awards grants to public and private partnerships to provide training and related services that support employment in high-growth and economic sectors that currently use H-1B visas to employ foreign workers, many of which are manufacturing occupations.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Registered Apprenticeship Program

Department of Labor, Employment and Training Administration

Funding for the Registered Apprenticeship Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$31	10-20%
Fiscal Year 2015	$34	10-20%
Fiscal Year 2016	$124	20%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey
Year program created: 1937

Program category: Training, Enhancing job seekers' skills

Program description: The Registered Apprenticeship program prepares American workers to compete in a global 21st Century economy. Registered Apprenticeship has already trained millions of U.S. workers through a network of 21,000 Registered Apprenticeship programs across the nation, consisting of over 150,000 employers.

Program activities that support manufacturing:
Training/technical assistance: The Department of Labor's (DOL) Office of Apprenticeship works in conjunction with independent State Apprenticeship Agencies to administer the program nationally. These state agencies are responsible for registering apprenticeship programs

that meet federal and state standards, protecting the safety and welfare of apprentices, issuing nationally recognized and portable Certificates of Completion to apprentices, promoting the development of new programs through marketing and technical assistance, assuring that all programs provide high quality training and produce skilled and competent workers.
Industry grants: The program awards grants as part of a broader commitment to create more opportunities by advancing job-driven training initiatives that help workers acquire the skills to succeed in currently available jobs. Under the American Apprenticeship Initiative Grant, 46 grantees have committed to expanding apprenticeship programs in new and growing industries, to align apprenticeships with further education and career advancement, and to expand the use of proven apprenticeship models that work.

Manufacturing Trends Addressed By the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	

Source: GAO analysis of survey data. | GAO-17-240

Trade Adjustment Assistance

Department of Labor, Employment and Training Administration

Funding for the Trade Adjustment Assistance Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing[a]
Fiscal Year 2014	$604	N/A
Fiscal Year 2015	$507	N/A
Fiscal Year 2016	$802	N/A

Source: GAO survey of agency officials. | GAO-17-240

[a]According to the Department of Labor, it does not track obligations exclusively for manufacturing workers served by the Trade Adjustment Assistance program.

Program Information Reported in Survey

Year program created: 1974

Program category: Training, Supporting workers who have been laid off from their job in manufacturing

Program description: DOL's Trade Adjustment Assistance program funds employment and training services to manufacturing and other eligible workers who lose their jobs as a result of the impact of global trade.

Program activities that support manufacturing:
Employment and case management services: Program participants receive employment and case management services, which include: (1) comprehensive assessments of skill levels and service needs; (2) development of an individual employment plan to identify employment goals and objectives; (3) information on available training and counseling, and how to apply for financial aid; (4) short-term prevocational services such as development of learning skills, communications skills, interviewing skills, among others; (5) individual career counseling; (6) provision of labor market information; (7) job referral and placement; and (8) information relating to the availability of supportive services.
Training that includes tuition-based courses or work-based learning: The program provides training, such as classroom training; on the-job training; customized training designed to meet the needs of a specific employer or group of employers; apprenticeship programs; post-secondary education; prerequisite education or coursework and remedial education, which may include General Equivalency Diploma preparation; literacy training; basic math; or English as a Second Language.
Relocation allowances and job search allowances: The program provides participants job search and relocation allowance reimbursements when seeking a job outside of the worker's commuting area or moving to a job that earns family-sustaining wages.
Trade readjustment allowances: Upon exhaustion of Unemployment Insurance benefits, program participants may be eligible to receive trade readjustment allowances that provide income support while participating in full-time training.
Reemployment trade adjustment assistance: Reemployment trade adjustment assistance provides wage supplements to reemployed program participants age 50 or older who do not earn more than $50,000 annually in their new employment. A qualified participant receives a wage supplement consisting of a portion of the difference between a worker's new wage and their old wage when they accept new employment at a lower wage than their previous employment.
Trade adjustment assistance program-related state administration funds: The program provides funds to cover related administration costs the state would incur in the provision of the program's benefits and services to trade-affected workers.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Trade Adjustment Assistance Community College and Career Training Grant

Department of Labor, Employment and Training Administration

Funding for the Trade Adjustment Assistance Community College and Career Training Grant Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$464	47-51%
Fiscal Year 2015	$0[a]	N/A
Fiscal Year 2016	$0[a]	N/A

Source: GAO survey of agency officials. | GAO-17-240

[a]There were no funds reported obligated in fiscal years 2015 and 2016, but the program continues to monitor existing grants.

Program Information Reported in Survey

Year program created: 2009

Program category: Training, Enhancing job seekers' skills

Program description: The Trade Adjustment Assistance Community College and Career Training Grant program provides community colleges and other eligible institutions of higher education with funds to expand and improve their ability to deliver education and career training programs that can be completed in 2 years or less; are suited for workers who are eligible for training under the Trade Adjustment Assistance for Workers program; and prepare program participants for employment in high-wage, high-skill occupations. These multi-year grants help ensure that institutions of higher education are helping adults succeed in acquiring the skills, degrees, and credentials needed for high-wage, high-skill employment while also meeting the needs of employers for skilled workers. DOL implements the program in partnership with the Department of Education.

Program activities that support manufacturing:

Workforce training related to manufacturing jobs: Grantees' capacity-building activities may include developing or enhancing programs of study that lead to industry-recognized credentials, purchasing approved training equipment, or renovating classroom or lab space to support training programs.

Information-sharing: The program makes all curriculum developed with program grant funds available as open educational resources using a creative commons copyright, and the curriculum is uploaded to the program's repository. This allows nonfunded training providers to further adapt and reuse grant-funded curriculum.

Providing training to trade-eligible workers and other unemployed or under-employed adults: According to program officials, program grantees are required to provide training to participants during their grant period of performance and to track certain performance metrics for those participants, and the training must lead to stackable credentials that are also industry-recognized, such as a certificate or associate's degree.

Strengthening relationships between manufacturing employers and community colleges: Grants support strengthening relationships between community colleges and manufacturing employers. Grantees engage employers in the manufacturing sector to create or strengthen programs of study through the design of curriculum and credentials; delivery of training; provision of internships and other work-based learning opportunities; contributions of equipment, facility, faculty, mentors; and hiring graduates of the training programs.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

E3 - Economy, Energy and Environment

Environmental Protection Agency

Funding for the E3 - Economy, Energy and Environment Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$5	45%
Fiscal Year 2015	$4	27%
Fiscal Year 2016	$3	25%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2009

Program category: Innovation, Applied research and development

Program description: The E3 - Economy, Energy and Environment program is a federal technical assistance framework comprising six federal agencies, including the Environmental Protection Agency (EPA), to provide support to small and medium-sized manufacturers. The program's mission is to help communities, manufacturers, and manufacturing supply chains adapt and thrive in today's green economy. In providing technical assistance, the program connects agencies and organizations in local communities and small and medium-sized manufacturers with experts from federal agencies, states, and regions.

Program activities that support manufacturing:
Technical assistance: EPA, in concert with five other federal agencies, provides technical reviews of manufacturing processes at small and medium-sized manufacturers and provides customized assessments detailing how participating manufacturers can incorporate practical sustainability approaches. The program's assessments aim to reduce energy consumption, minimize carbon footprints, prevent pollution, increase productivity, and drive innovation.

Manufacturing Trends Addressed by the Program

E3 has not directly engaged with advanced manufacturing work because the program is primarily targeted toward smaller manufacturers for whom a lack of environmental and lean manufacturing knowledge is an impediment to improving their operations. Some of these companies may supply other companies in the advanced manufacturing sphere. Agency

officials at DOL, who also support E3, may be engaged in enhancing workforce skills, but EPA is primarily concerned with improvements to manufacturing processes themselves.

Export-Import Bank of the United States

Export-Import Bank

Funding for the Export-Import Bank of the United States

	Reported obligations, in millions[a]	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$108	81%
Fiscal Year 2015	$107	83%
Fiscal Year 2016	$106	51%

Source: GAO survey of agency officials. | GAO-17-240

[a]These amounts represent the amounts obligated by the Export-Import Bank for administrative costs, which according to the Bank were paid by the fees charged to the foreign buyers of U.S. exports.

Program Information Reported in Survey
Year program created: 1945

Program category: Trade, Financial support

Program description: The Export-Import Bank of the United States is the official export credit agency of the United States. The Bank is an independent, self-sustaining (for budgetary purposes) federal agency that exists to support the export of U.S. goods and services, and thereby American jobs. The Bank's charter states that it should not compete with the private sector. Rather, the Export-Import Bank's role is to assume the credit and country risks that the private sector is unable or unwilling to accept, while still maintaining a reasonable assurance of repayment. In fiscal year 2015, the Export-Import Bank authorized 2,630 transactions supporting an estimated $17 billion in U.S. exports.

Program activities that support manufacturing:
Loans: Under this program, the Export-Import Bank provides fixed-rate loans directly to foreign buyers of goods and services.
Loan guarantees (including Working Capital Guarantees): These programs provide guarantees to commercial lenders to cover repayment risks on foreign buyer's debt obligations incurred to purchase U.S. exports. As described by program officials, under Working Capital

Guarantees, the Export-Import Bank provides repayment guarantees to lenders on secured, short-term working capital loans made to qualified exporters.

Export credit insurance: The Bank explained that export credit insurance supports U.S. exporters selling goods overseas by protecting the businesses against the risk of foreign buyer or other foreign debtor default for political or commercial reasons. This risk protection permits exporters to extend credit to their international customers where otherwise not possible, according to program officials.

Manufacturing Trends Addressed by the Program

The Export-Import Bank does not directly address manufacturing trends.

Advanced Technological Education Program

National Science Foundation, Division of Undergraduate Education

Funding for the Advanced Technological Education Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$64	25.4%
Fiscal Year 2015	$65	26.3%
Fiscal Year 2016	$66	28.2%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1993

Program category: Training, Enhancing job seekers' skills

Program description: With an emphasis on 2-year colleges, the Advanced Technological Education program focuses on the education of technicians for the high-technology fields that drive our nation's economy. The program involves partnerships between academic institutions and industry to promote improvement in the education of science and engineering technicians at the undergraduate and secondary school levels. The program supports curriculum-development, professional development of college faculty and secondary school teachers, career pathways to 2-year colleges from secondary schools and from 2-year colleges to 4-year institutions, and other activities. Another goal is articulation between 2-year and 4-year programs for K-12 prospective

science, technology, engineering, and mathematics teachers that focus on technological education. The program invites research proposals that advance the knowledge base related to technician education.

Program activities that support manufacturing:
Providing grants: The program provides grants for technician education at 2-year-degree granting institutions in many science, technology, engineering, and mathematics technology fields, including advanced manufacturing.
Support for other federal initiatives: The program supports the Advanced Technological Education Program support for manufacturing institutes and Investing in Manufacturing Communities Partnerships

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	

Source: GAO analysis of survey data. | GAO-17-240

Biotechnology and Biochemical Engineering

National Science Foundation, Division of Chemical, Bioengineering, Environmental, and Transport Systems

Funding for the Biotechnology and Biochemical Engineering Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$13	76-100%
Fiscal Year 2015	$14	76-100%
Fiscal Year 2016	$5[a]	76-100%

Source: GAO survey of agency officials. | GAO-17-240

[a]This amount is the reported obligations as of March 10, 2016.

Program Information Reported in Survey

Year program created: mid 1980s

Program category: Innovation, Basic research and development

Program description: The Biotechnology and Biochemical Engineering program supports fundamental engineering research that advances the understanding of cellular and biomolecular processes. This research

eventually leads to the development of enabling technology for advanced manufacturing and/or applications in support of the biopharmaceutical, biotechnology, and bioenergy industries, or with applications in health or for the environment. A quantitative treatment of biological and engineering problems of biological processes is considered vital to successful research projects in the program. The program encourages highly innovative and potentially transformative engineering research, which may lead to novel bioprocessing and manufacturing approaches and proposals that address emerging research areas and technologies that effectively integrate knowledge and practices from different disciplines while incorporating ongoing research into educational activities.

Program activities that support manufacturing:
Providing grants: The grants enable fundamental research toward developing new manufacturing technologies based on engineering biology.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Design of Engineering Materials Systems

National Science Foundation, Division of Civil, Mechanical, and Manufacturing Innovation

Funding for the Design of Engineering Materials Systems Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$1	100%
Fiscal Year 2015	$3	100%
Fiscal Year 2016	$2	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2012

Program category: Innovation, Basic research and development

Program description: The Design of Engineering Material Systems program supports fundamental research intended to lead to new paradigms of design, development, and insertion of advanced engineering material systems. For the purposes of this program, fundamental research includes research that develops and creatively integrates theory, processing/manufacturing, data/informatics, experimental, and/or computational approaches with rigorous engineering design principles, approaches, and tools to inform the accelerated design and development of materials. The program seeks research proposals that strive to develop systematic scientific methodologies to tailor the behavior of material systems in ways that are driven by performance metrics and incorporate processing/manufacturing. Ultimately it is expected that research outcomes will be methodologies to enable the discovery of materials systems with new properties and behavior and to also enable their rapid insertion into engineering systems.

Program activities that support manufacturing:
Providing grants: The grants support fundamental research in engineering and science. Awards may include research that leads to advanced engineering materials systems for manufacturing.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Engineering and Systems Design

National Science Foundation, Division of Civil, Mechanical and Manufacturing Innovation

Funding for the Engineering and Systems Design Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$6	50%
Fiscal Year 2015	$6	50%
Fiscal Year 2016	$5	50%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1982

Program category: Innovation, Basic research and development

Program description: The Engineering and Systems Design program supports fundamental research ultimately leading to new engineering and systems design methods and practices for specific global contexts. In particular, the program seeks intellectual advances in which the theoretical foundations underlying design and systems engineering are operationalized into rigorous and pragmatic methods for a specific context. In addition, the program funds the rigorous theoretical and empirical characterization of new or existing methods for design and systems engineering, identifying which global contexts and under which assumptions these methods are effective and efficient. Research in engineering and systems design should advance the state of knowledge of design methodology by adapting existing methods to a new context or by carefully characterizing existing or new design methods in a new context.

Program activities that support manufacturing:
Providing grants: The grants support fundamental research in engineering and science. Awards may include research that ultimately leads to new engineering and systems design methods and practices for manufacturing.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Industry/University Cooperative Research Centers Program

National Science Foundation

Funding for the Industry/University Cooperative Research Centers Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$5	25%
Fiscal Year 2015	$9	44%
Fiscal Year 2016	$3	18%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1973

Program category: Innovation, Applied research and development

Program description: The Industry/University Cooperative Research Centers program develops long-term partnerships among industry, academe, and government. The centers are catalyzed by a small investment from the National Science Foundation (NSF) and are primarily supported by industry center members, with NSF taking a supporting role in the development and evolution of the center. Each center is established to conduct research that is of interest to both the industry members and the center faculty. The program contributes to the nation's research infrastructure base and enhances the intellectual capacity of the engineering and science workforce through the integration of research and education.

Program activities that support manufacturing:
Providing grants: The program enables partnership between academia and industries to carry out pre-competitive research benefiting multiple industrial sectors, including manufacturing.

Training: The program helps train students and other researchers in industrially relevant research and prepares them as the workforce for U.S. industries, including manufacturing.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Manufacturing Machines and Equipment

National Science Foundation, Division of Civil, Mechanical, and Manufacturing Innovation

Funding for the Manufacturing Machines and Equipment Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$10	100%
Fiscal Year 2015	$10	100%
Fiscal Year 2016	$9	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 1983

Program category: Innovation, Basic research and development

Program Evaluations That Assessed Any Impact on the U.S. Manufacturing Sector

- Weber, C. (2013). The Role of the National Science Foundation in the Origin and Evolution of Additive Manufacturing in the United States. Institute for Defense Analyses Science and Technology Policy Institute.

Source: GAO survey of agency officials. I GAO-17-240

Program description: The Manufacturing Machines and Equipment program supports fundamental research that informs the development of new and/or improved manufacturing machines and equipment—and optimization of their use—with a particular focus on equipment appropriate for the manufacture of mechanical and electromechanical devices, products, and systems featuring scales from microns to meters. The program promotes proposals that relate to the manufacturing of equipment and facilities that enable the production of energy products. Other areas of research interest include a wide range of manufacturing operations, including both subtractive and additive processes, forming, bonding/joining, and laser processing.

Program activities that support manufacturing:
Providing grants: The grants support fundamental research in engineering and science. Awards may include research that leads to new manufacturing machines and equipment.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Materials Engineering and Processing

National Science Foundation, Division of Civil, Mechanical and Manufacturing Innovation

Funding for the Materials Engineering and Processing Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$17	100%
Fiscal Year 2015	$20	100%
Fiscal Year 2016	$19	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2013

Program category: Innovation, Basic research and development

Program description: The Materials Engineering and Processing program supports fundamental research addressing the processing and mechanical performance of engineering materials by investigating the interrelationship of materials processing, structure, properties and/or life-cycle performance for targeted applications. As part of its mission, the program focuses on manufacturing processes that convert material into useful forms as either intermediate or final composition. These include processes such as extrusion, molding, casting, deposition, sintering and printing.

Program activities that support manufacturing:
Providing grants: The grants support fundamental research in engineering and science. Awards may include research that ultimately leads to advanced engineering materials processing and performance for manufacturing.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Nanomanufacturing

National Science Foundation, Division of Civil, Mechanical, and Manufacturing Innovation

Funding for the Nanomanufacturing Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$8	100%
Fiscal Year 2015	$9	100%
Fiscal Year 2016	$8	100%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2001

Program category: Innovation, Basic research and development

Program description: The Nanomanufacturing program seeks to explore transformative approaches to nanomanufacturing. Nanomanufacturing is the production of useful nano-scale materials, structures, devices, and systems in an economically viable manner. The approaches supported by this program include, but are not limited to: micro-reactor and micro-fluidics enabled nanosynthesis, bio-inspired nanomanufacturing, manufacturing by nanomachines, additive nanomanufacturing, hierarchical nanostructure assembly, continuous high-rate nanofabrication, and modular manufacturing platforms for nanosystems. The program encourages the fabrication of nanomaterials by design, three-dimensional nanostructures, multi-layer nanodevices, and multi-

material and multi-functional nanosystems. Also of interest is the manufacture of dynamic nanosystems, such as nanomotors, nanorobots, and nanomachines, and enabling advances in transport and diffusion mechanisms at the nano-scale.

Program activities that support manufacturing:
Providing grants: The grants support fundamental research in engineering and science. Awards may include research that leads to the manufacture of useful nano-scale materials, structures, devices, and systems.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

National Robotics Initiative

National Science Foundation

Funding for the National Robotics Initiative

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$32	48%
Fiscal Year 2015	$31	50%
Fiscal Year 2016	Not reported	N/A

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2011

Program category: Innovation, Basic research and development

Program description: The goal of the National Robotics Initiative is to accelerate the development and use of robots in the United States that work beside or cooperatively with people. Innovative robotics research and applications emphasizing the realization of such co-robots working in symbiotic relationships with human partners is supported by multiple agencies of the federal government including NSF. The purpose of this program is the development of this next generation of robotics, to

advance the capability and usability of such systems and artifacts, and to encourage existing and new communities to focus on innovative application areas. It will address the entire life cycle from fundamental research and development to manufacturing and deployment.

Program activities that support manufacturing:
Providing grants: The program supports basic research in co-robots (robots that work with, or help, people). Much of the research is applicable to manufacturing; some of it is specifically aimed at improving the ability of robots to aid in manufacturing processes.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

Service, Manufacturing, and Operations Research

National Science Foundation, Division of Civil, Mechanical, and Manufacturing Innovation

Funding for the Service, Manufacturing, and Operations Research Program

	Reported obligations, in millions	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	Not reported	N/A
Fiscal Year 2015	$14	20%
Fiscal Year 2016	$15	25%

Source: GAO survey of agency officials. | GAO-17-240

Program Information Reported in Survey

Year program created: 2014

Program category: Innovation, Basic research and development

Program description: The Service, Manufacturing, and Operations Research program supports fundamental research leading to the creation of innovative mathematical models, analysis, and algorithms for decision-making related to design, planning, and operation of service, manufacturing, and other complex systems. Specifically, the program supports two main types of research: (1) innovations in general-purpose

methodology related to optimization, stochastic modeling, and decision and game theory; and (2) research grounded in relevant applications that require the development of novel and customized analytical and computational methodologies. Application areas of interest include supply chains and logistics; risk management; healthcare; environment; energy production and distribution; mechanism design and incentives; production planning, maintenance, process monitoring, and quality control; and national security. Of particular interest are methods that incorporate increasingly rich and diverse sources of data to support decision-making.

Program activities that support manufacturing:
Providing grants: The grants support fundamental research in engineering and science. Awards may include research that leads to advances in modeling and optimization for manufacturing.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		

Source: GAO analysis of survey data. | GAO-17-240

7(a) loan program

Small Business Administration, Office of Capital Access

Program Funding: Not reported.

Program Information Reported in Survey
Year program created: 1953

Program category: General financing

Program description: The 7(a) loan program is the largest of the Small Business Administration's (SBA) business loan programs. The mission is to assist small businesses in obtaining financing when they do not qualify for conventional credit by providing the credit enhancement of a federal guaranty. Loan guarantees can help underserved businesses that traditionally have trouble accessing capital through conventional credit markets. SBA loan guarantees are flexible enabling small businesses to obtain financing of up to $5 million for various business uses, with loan maturities up to 25 years depending on the type of assets being financed. SBA guarantees a portion of 7(a) loans made and administered by private

sector commercial lending institutions. Loans can be guaranteed for most legitimate general business purposes to businesses classified as small.

Program activities that support manufacturing:
Loans: The 7(a) program provides loan guarantees to small manufacturers. Loans can be made to start-up or existing manufacturers for many legitimate costs related to the opening, operations, and expansion of independent small manufacturing companies.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X		X

Source: GAO analysis of survey data. | GAO-17-240

Certified Development Company (CDC)/504 loan program

Small Business Administration, Office of Capital Access

Program Funding: Not reported.

Program Information Reported in Survey
Year program created: 1958

Program category: General financing

Program description: The 504 loan program is SBA's premier economic development program, providing "brick and mortar" and/or major equipment financing. The program has particular features, such as a statutorily-mandated job creation component, a community development goal, or a public policy goal achievement component, that help the agency facilitate job creation and enable the establishment and viability of small businesses.

P*rogram activities that support manufacturing:*
Loans: Fixed-rate, long-term financing for land, building, and equipment.

Manufacturing Trends Addressed by the Program

The Certified Development Company (CDC)/504 Loan Program provides financing for major fixed assets, such as equipment or real estate for the purpose of job creation/retention without regard to manufacturing trends in any one industry group. Loan proceeds used for the acquisition of equipment could result in addressing manufacturing trends. However, SBA does not track the types of equipment purchased.

Small Business Innovation Research

Small Business Administration, Office of Investment and Innovation

Funding for the Small Business Innovation Research Program

	Reported obligations, in millions[a]	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$2,276	12%
Fiscal Year 2015	$2,253	13%
Fiscal Year 2016	Not reported[b]	N/A

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the amounts reported obligated by federal agencies for the Small Business Innovation Research program. SBA did not obligate these funds. For more information, see GAO, Small Business Research Programs: Agencies Have Improved Compliance with Spending and Reporting Requirements, but Challenges Remain, GAO-16-492 (Washington, D.C.: May 26, 2016).

[b]According to SBA, these data are not yet available.

Program Information Reported in Survey

Year program created: 1982

Program category: Innovation, Applied research and development

Program description: SBA establishes the policy guidance for the Small Business Innovation Research (SBIR) program. The federal agencies that participate in the program must obligate a minimum percentage of extramural research and development funds for awards to small businesses. Funding from the participating agencies helps drive small research and development companies to innovate, strengthen U.S. competitiveness, and create jobs. The program helps small businesses develop innovations to meet the research and development needs of the federal government and then commercialize those innovations in the marketplace.

Program activities that support manufacturing:

Providing grants and contracts: Eleven federal agencies participate in the program by funding research and development in the manufacturing space.

Implement Executive Order 13329: According to agency officials, Executive Order 13329 requires SBIR/Small Business Technology Transfer (STTR) agencies to give high priority to manufacturing-related research and development and it further states that the federal government has an important role in advancing innovation, including innovation in the manufacturing sector, through small businesses. According to agency officials, the program Policy Directive states that participating agencies must, to the extent permitted by law, and in a manner consistent with the mission of that agency and the purpose of the SBIR program, give priority in the SBIR program to manufacturing-related research and development in accordance with Executive Order 13329. SBA collects information, as part of the annual reports submitted by participating agencies, regarding agency efforts to advance manufacturing through the programs.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Small Business Technology Transfer

Small Business Administration, Office of Investment and Innovation

Funding for the Small Business Technology Transfer Program

	Reported obligations, in millions[a]	Estimated percentage of reported obligations used to support U.S. manufacturing
Fiscal Year 2014	$231	20%
Fiscal Year 2015	$296	13%
Fiscal Year 2016	Not reported[b]	N/A

Source: GAO survey of agency officials. | GAO-17-240

[a]These numbers are the amounts reported obligated by participating federal agencies. SBA did not obligate these funds.

[b]According to SBA, these data are not yet available.

Program Information Reported in Survey

Year program created: 1992

Program category: Innovation, Applied research and development

Program description: SBA establishes the policy guidance for the STTR program. The federal agencies that participate in the program must obligate a minimum percentage of extramural research and development funds for awards to small businesses. The purpose of the program is to stimulate a partnership of ideas and technologies between innovative small business concerns and research institutions through federally funded research and development. By providing awards to small business concerns for cooperative research and development efforts with research institutions, the program assists the small business and research communities by commercializing innovative technology. Central to the program is expansion of the public/private sector partnership to include joint venture opportunities for small businesses and nonprofit research institutions. The unique feature of the program, according to agency officials, is the requirement for the small business to formally collaborate with a research institution in early phases of the research and development cycle.

Program activities that support manufacturing:
Providing grants and contracts: Five federal agencies participate in the program by funding research and development in the manufacturing area, as well as other areas.
Implement Executive Order 13329: According to agency officials, Executive Order 13329 requires SBIR/STTR agencies to give high priority to manufacturing-related research and development and it further states that the federal government has an important role in advancing innovation, including innovation in the manufacturing sector, through small businesses. The program gives priority in the STTR program to manufacturing-related research and development. SBA collects information, as part of the annual reports submitted by participating agencies, regarding agency efforts to advance manufacturing through the programs.

Manufacturing Trends Addressed by the Program

Advanced manufacturing	Higher skilled jobs	Globalization
X	X	X

Source: GAO analysis of survey data. | GAO-17-240

Appendix III: GAO Contacts and Staff Acknowledgments

GAO Contacts

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